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ABSTRACT

The ocean affects all of our lives. Therefore, awareness of and information about the interconnections between humans and oceans are prerequisites to making sound decisions for the future. Project ORCA (Ocean Related Curriculum Activities) has developed interdisciplinary curriculum materials designed to meet the needs of students and teachers living in Washington State. Each activity packet provides the teacher with a set of lessons dealing with a particular topic related to the oceans. Included are student worksheets, lesson plans, a vocabulary list, and a bibliography. This packet, designed for grade levels 3-4, is an introduction to life at the rocky shore. The packet introduces students to 12 common rocky shore animals including: (1) barnacles; (2) mussels; (3) limpets; (4) periwinkles; (5) shore crabs; (6) hermit crabs; (7) sea stars; (8) tidepool sculpins; (9) blennies; (10) sea anemones; (11) sea urchins; and (12) seagulls. It describes life on a rocky shore; how the animals move, gather their food, and behave at high tide and low tide. The packet emphasizes role-playing as a method of helping children understand the situation of living plants and animals. In addition, the packet is intended to help students develop appreciation for natural beauty and positive attitudes towards the preservation of seashore life. (TW)

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# HIGH TIDE, LOW TIDE

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**ORCA**

## OCEAN RELATED CURRICULUM ACTIVITIES

**PACIFIC SCIENCE CENTER / SEA GRANT**
**MARINE EDUCATION PROJECT**

Andrea Marrett, Manager
Gloria Snively, Writer
Susan Lundstedt, Illustrator

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## ORCA PUBLICATIONS

### ELEMENTARY

High Tide, Low Tide (4th Grade)
Life Cycle of the Salmon (3rd - 4th Grade)
Waterbirds (4th - 5th Grade)
Whales (4th - 6th Grade)

### JUNIOR HIGH

Beaches
Beach Profiles and Transects
Early Fishing Peoples of Puget Sound
Energy from the Sea
Literature and the Sea
Tides
Tools of Oceanography

### SENIOR HIGH

American Poetry and the Sea
Marine Biology Activities
Marine Biology Field Trip Sites
Marshes, Estuaries and Wetlands
Squalls on Nisqually: A Simulation Game

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# PROJECT ORCA

The ocean? It's 2 miles away; it's 200 miles away; it's 2000 miles away. What does it matter to me? For those students who live close to the ocean, a lake or a stream, the effect of water might be more obvious. For the student who lives on a wheat farm in the arid inlands, the word ocean is remote. It may conjure up images of surf, sand and sea gulls, experiences far removed from their daily lives; or it may have no meaning at all. Yet for that same youngster, the reality of the price of oversea wheat shipments or fuel costs for machinery are very real. The understanding of weather and its effects on the success or failure of crops is a basic fact of everyday life. The need for students to associate these daily problems with the influence of the marine environment exists. It requires exposure to ideas, concepts, skills and problem solving methods on the part of the youngsters. It also requires materials and resources on the part of our educators.

The goals of ORCA (Ocean Related Curriculum Activities) are: 1) to develop a basic awareness of ways in which water influences and determines the lives and environments of all living things; and 2) to develop an appreciation of the relationship of water to the study of the natural sciences, social sciences, humanities and the quality of life.

ORCA attempts to reach these goals by: 1) developing interdisciplinary curriculum materials designed to meet the needs of students and teachers living in Washington State, 2) developing a marine resource center, and 3) providing advisory services for marine educators. In conjunction with these efforts, ORCA is coordinating communication among educators throughout the state and the rest of the nation.

The curriculum materials are developed to be used in many areas including the traditional science fields. They consist of activity packets which fit existing curricula and state educational goals and are designed for use as either a unit or as individual activities.

The ocean affects all our lives and we need to be aware and informed of the interconnections if we are to make sound decisions for the future of the earth, the ocean and our own well being. We hope that through Project ORCA, teachers will be encouraged to work together to help students understand and appreciate the ocean and the world of water as a part of our daily existence.

# ACKNOWLEDGEMENTS

The elementary series of ORCA (Ocean Related Curriculum Activities) is a product of a cooperative effort. The materials were developed at the Pacific Science Center with assistance provided by the National Oceanic and Atmospheric Administration (NOAA) Sea Grant, held by the University of Washington.

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Mark Terry, Associate Director, Environment, The Northwest School of the Arts, Humanities, and the Environment, Seattle
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## STAFF

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# HIGH TIDE, LOW TIDE

**ABSTRACT:**

High Tide, Low Tide is an introduction to life at the rocky shore. The packet introduces students to twelve common rocky shore animals: barnacles, mussels, limpets, periwinkles, shore crabs, hermit crabs, sea stars, tidepool sculpins, blennies, sea anemones and sea urchins. It describes life on a rocky shore; how the animals move, gather their food, and behave at high tide and low tide. It explains how rocky shore animals survive harsh conditions; how they protect themselves from drying out at low tide, how they protect themselves from predators, and how they keep from being battered to death when the tide comes in. The packet emphasizes role-playing as a method of helping children understand the situation of living plants and animals. In addition, the packet is intended to help students develop appreciation for natural beauty and positive attitudes towards the preservation of seashore life.

**SUBJECTS:** Science, reading, creative writing, creative drama, role-playing, art and music.

**GRADE LEVELS:** 3 - 4 (Can be adapted for grades 1 and 2.)

**WRITTEN BY:** Gloria Snively

# TABLE OF CONTENTS AND OVERVIEW

## ACTIVITY 1: THE ROCKY SHORE (2 DAYS) 10

Students learn that our coastline is made up of different types of seashores: rocky shores, sandy beaches, mud flats, and mixed cobblestone beaches of sand, gravel and mud. The rocky shore is a battleground between the land and the sea. In this war with the land, the sea's weapons are water, air and stones. The students make observations from pictures depicting types of seashores.

## ACTIVITY 2: HIGH TIDE, LOW TIDE (2 DAYS) 14

The concept of tide is introduced. Students make observations from seashore pictures depicting high and low tide. Students learn that tidal pools, small pools of seawater, are left on rocky shores when the tide goes out.

## ACTIVITY 3: PLANKTON SOUP (3 DAYS) 20

Students learn that the sea is crowded with tiny microscopic plants and animals that drift near the surface of the sea. The concept of energy from the sun is introduced. Students dramatize planktonic plants and animals and write stories and poems relating their own creative drama experiences.

## ACTIVITY 4: SEAWEEDS (2 DAYS) 26

Students learn about the seaweed forests in the ocean and the thin film of tiny plants covering every centimeter of every rock. They learn that plants need light to grow. Students dramatize seaweeds at high tide and at low tide.

## ACTIVITY 5: SEAGULLS (2 DAYS) 32

At low tide seagulls gain entry to the tidelands and begin picking and probing with their long sharp bills for small snails, crabs and worms. The concepts of predator and prey are introduced. Students dramatize seagulls at high tide and at low tide.

## ACTIVITY 6: BARNACLES (3 DAYS) 38

At high tide, or when covered with seawater, barnacles sweep the water for microscopic plants and animals (plankton). But at low tide, or when out of seawater, barnacles close up tightly to protect themselves from shore predators and from drying out. Students role-play barnacles at high tide and at low tide, and write realistic stories describing how barnacles survive life at the seashore.

### ACTIVITY 7: PERIWINKLES (2 DAYS) 44

Students learn that at high tide periwinkles move about scraping on the thin carpet of plants that covers the rocks. But at low tide, or when out of seawater, periwinkles withdraw into their shellhouses to protect themselves from predators and from drying out. Students dramatize periwinkles at high tide and at low tide. From their role-playing activities, the students draw pictures of periwinkles feeding at high tide and periwinkles withdrawn inside their shellhouses at low tide.

### ACTIVITY 8: MUSSELS (2 DAYS) 50

Students learn that at high tide, or when covered with seawater, mussels open their two shells to feed on plankton soup. But at low tide, or when out of seawater, mussels close up tightly to protect themselves from seagulls and from drying out. Students role-play mussels at high tide and at low tide and draw pictures of mussels at high tide and at low tide.

### ACTIVITY 9: LIMPETS (2 DAYS) 56

At high tide the cone-shaped limpets feed on the thin carpet of plants that covers the rocks. But at low tide, or when out of seawater, limpets plaster themselves to the rocks with a very strong suction which protects them from shore predators and from drying out. Students role-play limpets at high tide and at low tide and draw accompanying pictures.

### ACTIVITY 10: SHORE CRABS (2 DAYS) 60

Students learn that at high tide shore crabs scurry over the rocks or creep among seaweeds looking for food. But as the tide goes out to sea, shore crabs move into tidal pools or hide under rocks to protect themselves from the drying sun and from shore predators. Students role-play shore crabs at high tide and at low tide, and write stories relating their experiences.

### ACTIVITY 11: SEA STARS (2 DAYS) 66

Students learn that at high tide, or when covered with seawater, sea stars move easily about in search of food. Sea stars need water to support their large, heavy bodies and water to make their tube feet work. As the tide goes out, the sea stars firmly attach themselves to rocks or to whatever they happen to be eating. When out of seawater, their hard, spiny skin keeps the moisture in. Students role-play sea stars at high tide and at low tide.

### ACTIVITY 12: TIDEPOOL SCULPINS (2 DAYS) 72

Students learn that at high tide sculpins glide from rock to rock gobbling up food. Sculpins either swim out to sea with the out-going tide, or slip into tidal pools. Sculpins are color-change artists and can blend perfectly with the rocks, seaweeds and shadows of the pool. Students role-play sculpins at high tide and at low tide.

## ACTIVITY 13: BLENNIES (2 DAYS) 78

At high tide and when in tidal pools, blennies swim with writhing, snake-like movements looking for food. But at low tide blennies either swim out to sea or hide under rocks or slip into tidal pools. Blennies are covered with a thin coat of protective slime that enables them to slither under rocks and into hiding places. At low tide the coat of slime and the under-rock shelters protect the blennies from shore predators and from drying out. Students role-play blennies at high tide and at low tide.

## ACTIVITY 14: HAIRY HERMIT CRABS (2 DAYS) 82

Students learn that at high tide and when in tidal pools, hermit crabs busily go about their business of searching for food. Hermit crabs live in empty snail shells because of their soft, curled bodies. As they grow, they must constantly find a larger shellhouse. At low tide, or when out of seawater, a hermit crab withdraws into its snail shell and uses it's large claws for blocking the entrance of the shell. Students role-play hermit crabs at high tide and at low tide and write stories depicting how hermit crabs survive life at the seashore.

## ACTIVITY 15: SEA ANEMONES (3 DAYS) 88

Students learn that at high tide and when in tidal pools sea anemones open to trap unsuspecting sea creatures for food. But at low tide, or when out of seawater, sea anemones draw in their stinging tentacles and close up their sac-like bodies. Students role-play sea anemones at high tide and at low tide and write illustrated stories describing how sea anemones respond to the rise and fall of the tide.

## ACTIVITY 16: SEA URCHINS (2 DAYS) 94

Students learn that at high tide, or when in tidal pools, sea urchins move about grazing on the seaweed forests. But at low tide, or when out of seawater, sea urchins stop moving and stop scraping at the seaweed forest. They need the surrounding seawater to support their heavy bodies and make their long, sharp spines and tube feet work. Students role-play how sea urchins respond to the changing tide and draw pictures illustrating how sea urchins react to changing tidal conditions.

**ACTIVITY 17: FIELD TRIP TO A ROCKY SHORE (1 DAY)** 100

Students explore a rocky shore to investigate first hand the way of life at the seashore. Students identify common rocky shore animals, observe tidal pools, and conduct simple inquires with seashore animals.

**EVALUATION, VOCABULARY** 106

# OBJECTIVES

After completing the Activity Packet, students will be able to:

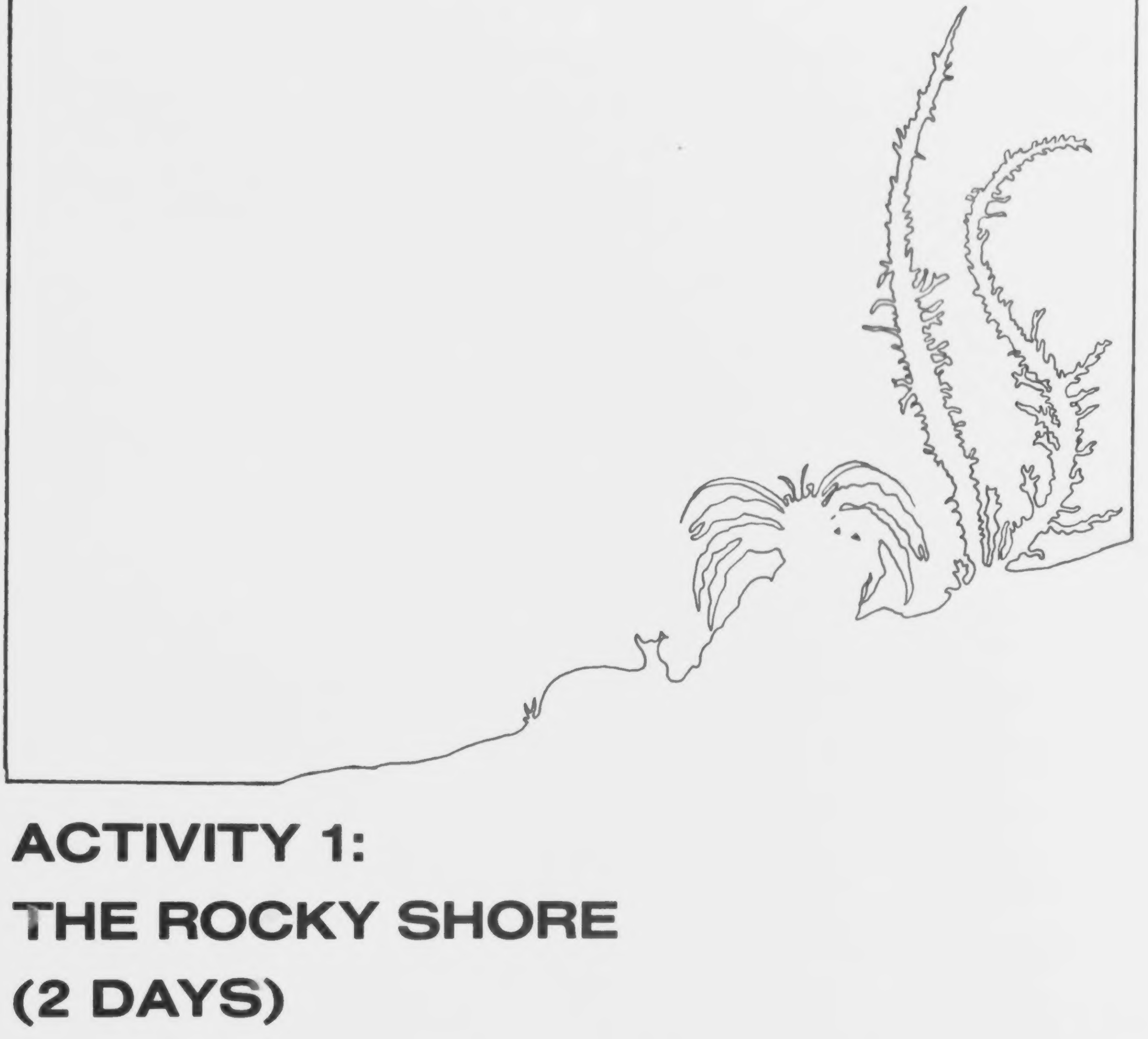
1. describe high tide and low tide.
2. describe the types of seashores; rocky shores, sandy beaches, mud flats, mixed cobblestone beaches.
3. define what tidal pools are.
4. define what plankton is.
5. define what seaweed is.
6. name and identify at least 12 common rocky shore animals.
7. explain different ways rocky shore animals have of getting from place to place.
8. explain different ways rocky shore animals have of getting their food.
9. explain different ways rocky shore animals keep from being battered to death when the tide comes in.
10. explain different ways rocky shore animals protect themselves from other rocky shore animals.
11. explain different ways rocky shore animals keep from drying out at low tide.
12. increase their skills to observe at the seashore.
13. increase their skills to ask questions.
14. increase their skills to investigate answers to their own questions.
15. role-play how rocky shore animals behave at high tide and at low tide.
16. use their imaginations to write stories, legends and poems about seashore plants and animals.
17. draw pictures of rocky shore animals at high tide and at low tide.
18. list and follow rules for protecting seashore plants and animals.
19. develop positive attitudes towards living things.
20. develop an appreciation for nature's beauty.

## PLAN AHEAD

1. For Activity 1, find some pictures of rocky beaches at high and low tide or contact the Marine Education Project at the the Pacific Science Center for the slide set for High Tide, Low Tide.
2. Ask the students to collect seashore pictures, photographs, postcards, posters, seashells, etc., from home. These items could serve as a basis for individual seashore scrapbooks; for writing poems, haiku, and stories; for art and science activities, etc.
3. The High Tide, Low Tide reader was written for a third or fourth grade reading level. Teachers of grades K-2 may want to read it to their students. Teachers of grades 3-4 may have their students read the story for themselves.
4. There are several ways to use the reader. Teachers may want to consider which approach would be most interesting, successful and useful with their students. Each approach requires a different form of preparation. Some suggestions are:
   - A. Use the reader as a story book, with students reading the story.
   - B. Use the pictures/drawings from the story and have the students create their own story.
   - C. Use the story as written and have the students illustrate it. (This may be done so that each student illustrates his/her own story or each invdividual may be assigned 1 or 2 illustrations to do. Post the illustrations around the room when completed.)
5. Copy the Student Reading Book. How the teacher decides to use the story will determine how it is reproduced (with or without the drawings and/or story line.) However, here is some information and suggestions:

   The Teacher's Guide is divided into seventeen activities. The Student Reading Book is located in the back of the Teacher's Guide. You might want to:
   - A. Reproduce the entire reader at one time and distribute to students to keep.
   - B. Reproduce the specific sections and hand out only as needed.
   - C. Make an extra copy of the reader for yourself and keep it in a 3 ring binder as a separate "book."

6. In the procedures section of the activities are questions with suggested answers. It is not intended, nor desired, that the students be asked all the questions or be expected to write out the answers. Choose sample questions for the students as a spot check for their comprehension.



# ACTIVITY 1:
# THE ROCKY SHORE
# (2 DAYS)

# ACTIVITY 1: THE ROCKY SHORE (2 DAYS)

**CONCEPTS:**

1. Coastlines are made up of different types of seashores:
    a. rocky shores
    b. sandy beaches
    c. mudflats
    d. mixed cobble, sand and mud beaches
2. The sea uses water, air and stones as weapons against the land.

**OBJECTIVES:**

The students will be able to:

1. identify a rocky shore.
2. identify a sandy beach.
3. identify a mudflat.
4. identify a mixed beach of cobbles, sand and mud.

**TEACHER PREPARATION:** Read Teacher Information.

**MATERIALS:**

1. large color pictures or slides of rocky, sandy, muddy, and mixed seashores. (Contact the Pacific Science Center, Marine Education, to reserve them, or take picture of your local seashore.)
2. large color pictures or slides of tidal pools. (Contact the Pacific Science Center, Marine Education, to reserve them.)

**PROCEDURES:**

1. Ask the children if they have ever visited the seashore. Where? When? What type of shore was it: rocky, sandy or muddy?

2. What did they see at the seashore? Write a list on the blackboard or on a piece of butcher paper.

3. What did they like best about visiting the seashore? List.

4. Classifying Types of Shores: show the children the pictures of seashores. Ask them to group the pictures according to the type of shores: rocky, sandy, muddy, or mixed.

5. Tell the children that the rocky shore is a battleground between the land and the sea. In this war with the land, what are the sea's weapons? (water, air, and stones)

6. Fill a gallon jar (preferably a clear plastic container) with beach pebbles, gravel, sand, mud and water. Gently shake the container. Make predictions, observations, and inferences. Repeat the experiment. Are the results the same?

7. My Secret Shore: This is a good activity to motivate children to read the book, "High Tide, Low Tide" and to explore the seashore first hand. Project slides of beautiful seascapes, or use large color photographs. (If possible, use rocky shore pictures.) Have the children sit close to

the images. Ask them to imagine themselves at that very same beach. Discuss the questions listed below. Use a felt pen to record their comments on butcher paper, and keep the butcher paper for later reference.

a. What things do you see? Describe how they look.

b. What things might you taste? Describe how they might taste.

c. What things might you touch. Describe how they might feel.

d. Tell the children to close their eyes and listen. What things do they hear? Make the sounds.

e. What things can they smell. Describe the smells.

f. What things do they like about this place. Why?

g. What things do they not like about this place. Why?

h. Would they like to go there? Why or why not?

i. What would they do with their time?

j. Tell the children that they are going to visit a very exciting rocky shore in the book, "High Tide, Low Tide." (If you plan to organize a field experience to a rocky shore, this is a good time to open discussions with the children.)

k. Use pastels, water colors, or tempera to paint seascapes.

l. Write a class story or poem called, "My Secret Shore."

## THE ROCKY SHORE

A rocky shore is a battleground where the sea attacks the land. Everywhere you see signs of the struggle; rocks sculptured by waves, boulders torn from the land, pebbles polished by the sea, caves and surge channels scoured in the bedrocks, and depressions holding pools of seawater when the tide falls. Huge winter storm waves and high tides hammer the rocks. Waves may undercut the coast and carve out cliffs.

In this war with the land, the sea's weapons are water, air, stones and water's power to dissolve. Any bits of stone that break off the cliffs join the sea's artillery of boulders, pebbles and sand grains with which the waves bombard and weaken the cliffs. Day by day, year by year, the sea continues to attack the cliffs, taking advantage of every weakness, until the cliffs retreat and the sea pushes steadily inward.

Rocky shores are not the only type of bottom encountered between the tides. There are also clean sandy beaches, mixed cobblestone beaches of sand, gravel and mud, and mud flats.

# ACTIVITY 2:
# HIGH TIDE, LOW TIDE
# (2 DAYS)

# ACTIVITY 2: HIGH TIDE, LOW TIDE (2 DAYS)

**CONCEPTS:**

1. Twice each day the tide rises and falls along our shores.
2. At high tide the seashore is covered with ocean water.
3. At low tide the seashore is exposed to air, wind, rain and sunlight.
4. At low tide, tidepools are left in holes and cracks on rocky shores.

**OBJECTIVES:**

The children will be able to:

1. describe the rise and fall of the tides.
2. know that the tides are caused by the pull of the moon.
3. group pictures of seashores into high tide and low tide.
4. make inferences about how the rise and fall of the tide affects seashore plants and animals.
5. identify a tidal pool.

**TEACHER PREPARATION:** Read Teacher Information.

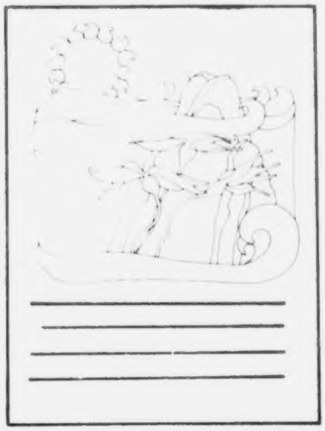
**MATERIALS:** Pictures of seashores at high tide and low tide.

**PROCEDURES:**

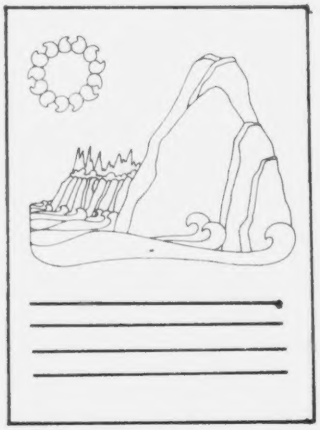
1. Show the students pictures of seashores at high tide and at low tide. Review the following: How many students have been to a rocky shore at high tide? Where? When? What did the shore look like? How long did it take for the tide to go out? What happened to the seaweeds at low tide? How was the seashore different at high tide than at low tide?

2. Have the children group the pictures into high tide and low tide.

3. Read "High Tide at the Rocky Shore" and "Low Tide at the Rocky Shore" in the Student Reading Book.



High Tide



Low Tide

4. Questions for discussion: (Encourage pupils to respond and accept all answers. Tell the children that you will read on in the story "High Tide, Low Tide" to find the answers.)

   High Tide at the Rocky Shore
   - A. How often does the tide rise and fall along our shoreline? [Twice each day the ocean waters rise and fall.]
   - B. What are tides? [The rising and falling of ocean waters are called tides.]
   - C. Brain Buster Question: Seashore animals must protect themselves at high tide. From what must they protect themselves? [From other seashore (intertidal) animals and from animals that swim in from deep water]

5. Low Tide at the Rocky Shore - Questions for discussion:
   - A. Where does the ocean water go at low tide? [Out to sea]
   - B. What are tidal pools? [Glassy, blue pools of water left in holes and cracks when the tide goes out]
   - C. Why do whole cities of animals live in tidal pools? [Because tidal pools provide shelter from the drying sun when the tide goes out ]
   - D. Brain Buster Question: (Accept all answers, and say, "Let's read on to find out.) Seashore plants and animals must protect themselves from drying out at low tide. What makes seashore plants and animals dry out? [The hot sun, air, wind]
   - E. Brain Buster Question: (Accept all answers, and say, "Let's read on to find out.") How might seashore animals keep from drying out at low tide? [Hide under seaweeds, live in tidepools, hide under rocks, dig into sand or mud]
   - F. Brain Buster Question: What shore animals might come down to the seashore at low tide to feed on seashore plants and animals? [Eagles, seagulls, crows, racoons, river otters, rats, mice, snakes, man]

   *Teacher's Note: Throughout the story stress the point that not all rocky shore animals are left stranded out of seawater at low tide. Even at low tide every tidal pool contains a community of plants and animals: some attach themselves to the sides; some are bottom dwellers; others are free-swimming. For example, at low tide a barnacle out of seawater closes up tight, but a barnacle attached to the walls of a tidal pool may continue to sweep the water for planktonic food.

6. Optional Field Trip Activities:

   A. At the seashore how can you tell if it is high tide or low tide? Find five signs of the effect of tidal changes. Can you see water moving out?
   B. Find an area near the shore that is just exposed as the tide begins to go out. Place a marker where the sand and water meet. Record the time. For the next four, half hour blocks of time, mark where the sand and water meet. Measure the distance between markers. Record what you find. Draw pictures of the beach at high tide and at low tide. Take photographs. What have you learned about tidal changes?
   C. Find a dock piling or vertical rock face. Make comparisons with activity "B" above.
   D. How will you know when the tide turns? Find five signs of the tide changing.
   E. Use thermometers to measure the temperature of tidepools located at various positions on the beach. What is the temperature of the air? The ocean? Discuss how tidepool plants and animals are able to survive under such extreme temperature changes.
   F. Taste the seawater. Describe the taste.

# HIGH TIDE, LOW TIDE

On all the seacoasts of the earth, the ocean waters rise and fall daily in a rhythmic movement known as the tides. This rising and falling of the tides is caused by the gravitational pull of the sun and the moon. Because the moon is much nearer to the earth than the sun it has a stronger pull than the sun.

# ACTIVITY 3:
# PLANKTON SOUP
# (3 DAYS)

## ACTIVITY 3: PLANKTON SOUP (3 DAYS)

**CONCEPTS:**

1. Diatoms are tiny floating plants.
2. A mixed crowd of tiny plants and animals, called plankton, drift near the surface of the sea.
3. Diatoms need energy from the sun to grow.

**OBJECTIVES:**

The student will be able to:

1. explain that plankton is a mixture of tiny, drifting plants and animals.
2. explain why plants use energy from the sun.

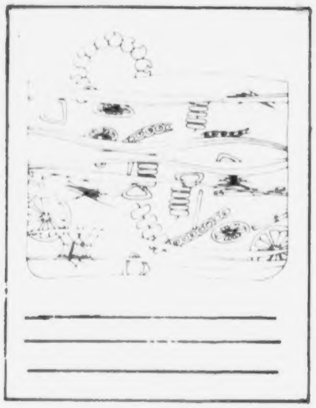
**TEACHER PREPARATION:** Read "Teacher Information" and "Plankton Soup."

**MATERIALS:**

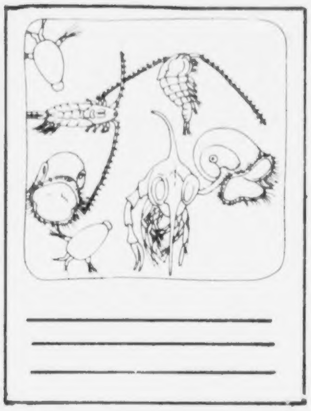
1. Class set of "High Tide, Low Tide."
2. If possible, pictures of plankton.

**PROCEDURES:**

1. Read "Plankton Soup" in "High Tide, Low Tide."



Plant Plankton



Animal Plankton

2. Possible questions for discussion:
   - A. What are diatoms? [Tiny, floating plants that live in the ocean]
   - B. What do diatoms look like? [Some look like glass boxes, some like twinkling stars, and some like sparkling jeweled necklaces.]
   - C. Why do diatoms drift near the surface of the sea? [They need sunlight to grow.]
   - D. Introduce the word energy. Tell the students that all living things require energy to grow. Plants need energy from the sun. Animals get energy when they feed on plants or on other animals.

E. The sea is crowded with tiny animals. What size are the animals? [Some are the size of pinheads. Some are insect-sized.]

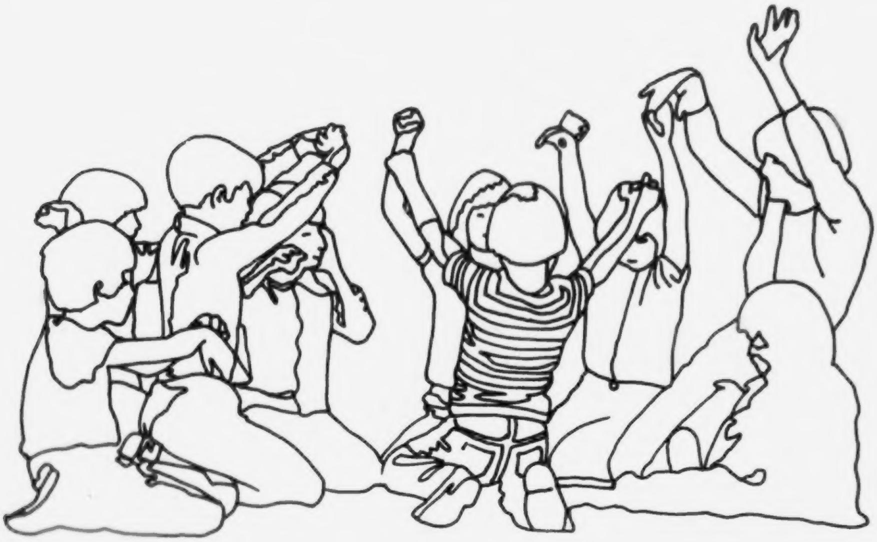
F. What do the animal plankton look like? [They are dragon-like animals with long swishing tails, long sharp horns, and feathery tails.]

G. If hundreds of plant and animal plankton can fit into a drop of water, how do we know what they look like? [We can see them with a microscope.]

3. Creative Drama

A single word, like "twinkling" or "floating" can set a child in motion. That word provides a picture, an association with something he or she has seen or felt. As we paint word pictures in which children experience language, similarly, in creative movement we make a visible "word picture" out of "floating" and "drifting." Such simple exercises help children understand that creative movement is yet another way of telling a story.

Simple exercises like "Be sparkling, jeweled diatoms drifting near the surface of the sea" are best for beginners at creative movement. And, as the children do the same thing around you, you do it too! Set a supportive and non-critical atmosphere in the creative movement sessions. Let the children develop at their own pace without fear of comparisons or competition.



Dramatizing diatoms is a good way to help children relax and feel comfortable. Tell them to pay attention to how the shape feels and not so much how it looks. Spread out in the gym or push back the chairs in the classroom. When possible, spread out on a sandy beach at low tide or in a grassy meadow. Tell the children to close their eyes and imagine a triangular diatom. What does it look like? BECOME A TRIANGULAR DIATOM (e.g., legs stradled, arms at side). How many different ways can you make a triangular diatom? Show me one way. Show me another way. BE A PIN-SHAPED DIATOM. Stretch as tall as you can. Reach to the ceiling on tip toes. Be thin and firm, chest pulled in. Be diatoms drifting silently, weightlessly, endlessly in the sunlit sea.

A. Be diatoms drifting in the sunlit sea. BECOME DIATOMS. You are:
   1. glass boxes
   2. twinkling stars
   3. glass triangles
   4. glass needles
   5. dots
   6. pin-shaped diatoms

B. Work in groups of 3, 4, or 5. Make a sparkling jeweled necklace of tiny glass boxes strung together.

C. Dance of the Diatoms. Play a record such as "Handel's Water Music," or "Neil Diamond's Jonathon Livingston Seagull," or Gershwin's "Rhapsody in Blue." Turn the lights down low. Ask the children to close their eyes and imagine themselves as beautiful diatoms. They are jeweled diatoms drifting silently, weightlessly, endlessly, in the sunlight sea.

D. Dance of the Copepods. Become tiny, tiny planktonic animals; copepods, amphipods, isopods. BECOME DRAGON-LIKE ANIMALS WITH LONG SWISHING FEELERS, LONG SHARP HORNS, AND FEATHERY TAILS. Feel yourself silently darting, swaying, drifting near the surface of the sea.

   Become a mixed crowd of tiny plants and tiny animals drifting silently near the surface of the sea. Tons and tons of sparkling diatoms and tons and tons of pinhead-sized animals. Be diatoms creating your own food from the sun's energy. Be copepods, amphipods, and isopods ... prancing, darting, feeding on diatoms and on the smaller of your own kind.

4. Creative Writing

With the idea of bringing word pictures, creative movement and creative writing together, discuss the children's creative movement experiences: How did they feel? What did they like? What did they think about? How did they develop their creative movement sequences? Eventually the children will come to the understanding that both words and movement are speaking to them and about them.

Ask the children to choose one of the following and write a short poem or story.

A. Pretend you are a sparkling glass diatom. Tell about your travels.

B. Pretend you are an insect-sized copepod, amphipod, or isopod. Tell about your travels.

C. Write about the crashing, booming, roaring ocean.

D. Write about the sleeping, whispering, resting ocean.

5. Optional Field Trip Activities

A. Observe the small microscopic plants and animals that make up plankton soup. Use a gallon jar or clear plastic container. Lower the jar halfway into a tide pool. Looking through the jar, train your eyes to focus on these extremely tiny organisms. Be patient! The rewards are many.

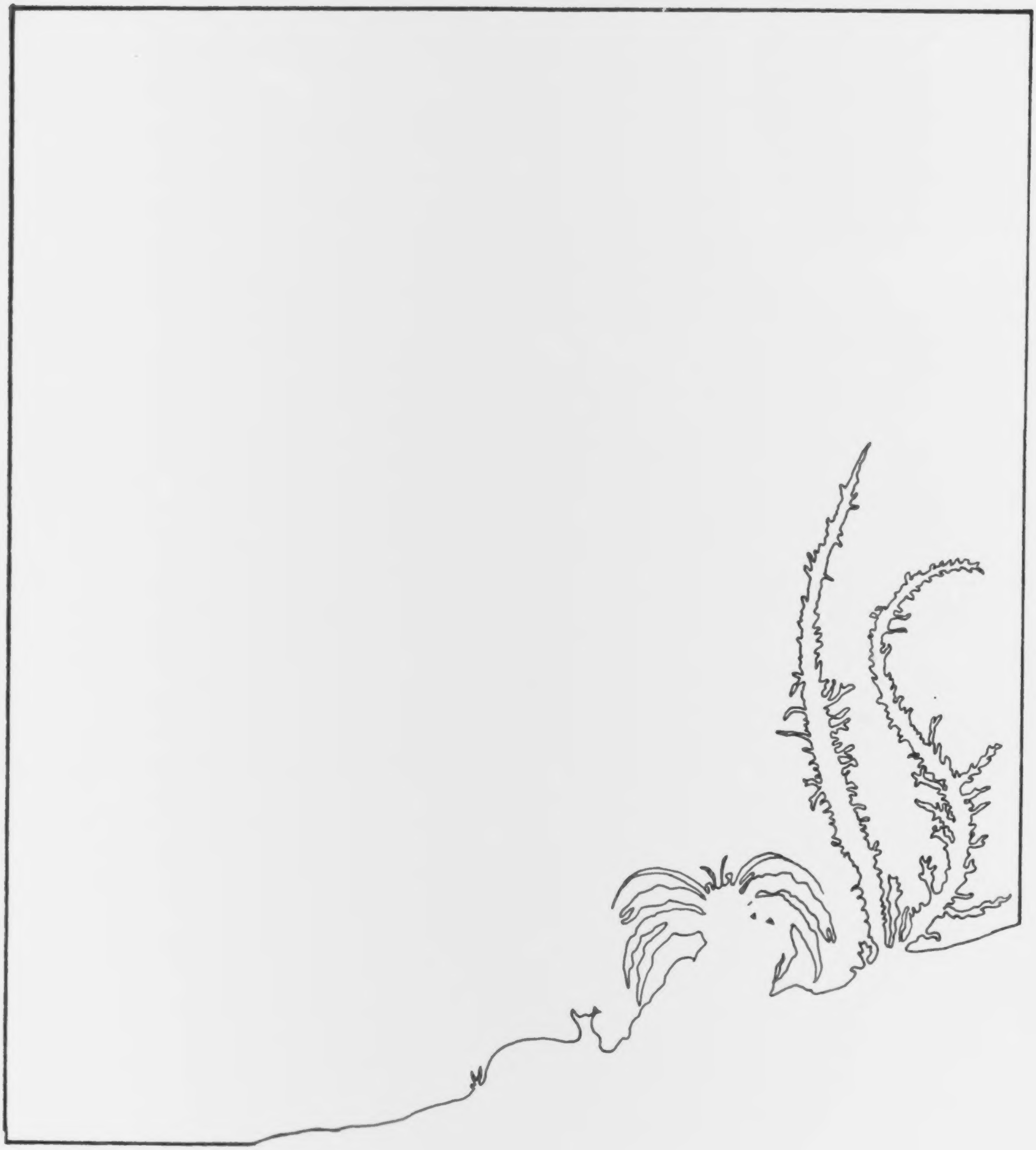
B. Look at plankton under a microscope.

# PLANKTON SOUP

In the ocean the sun's energy shines down into the water for about two hundred feet, then the light fades away into darkness. Because plants need light to grow, the part of the ocean that is lit by the sun is crowded with plant plankton, but there are no plants where the sea is dark.

The smallest plants in the ocean are known as phytoplankton, phyto meaning "plant" and plankton meaning "wanderer." These tiny floating plants of the ocean are mostly diatoms and a lesser number of other types of plant plankton. When seen under a microscope, diatoms have a highly decorated shell; some look like glass boxes, others like sparkling diamonds or twinkling stars, and those that are joined together in long chains look like jeweled necklaces. Diatoms create their own food from the sun's energy.

The smallest animals in the ocean are known as zooplankton, zoo meaning "animal" and plankton meaning "wanderer." Seen under a microscope a zooplankton may look something like a dragon, with bristling legs and long swishing antennae. There are thousands of kinds of animal plankton: copepods, amphipods, isopods, etc. Copepods are one of the most important group because they feed on diatoms and are at the base of the food chain. Copepods reproduce very rapidly and are food for hordes of larger zooplankton, as well as countless shrimp, certain fishes, and filter feeders such as clams, mussels, oysters, barnacles and some whales.



# ACTIVITY 4: SEAWEEDS (2 DAYS)

## ACTIVITY 4: SEAWEEDS (2 DAYS)

**CONCEPTS:**

1. Seaweeds are large plants that form a seaweed forest in the ocean.
2. All plants need energy from the sun.
3. A thin carpet of tiny green or brown plants covers the rocks.

**OBJECTIVES:**

The students will be able to:
1. list characteristics of seaweeds.
2. compare seaweeds with land plants.
3. role-play seaweeds at high tide and low tide.

**TEACHER PREPARATION:**

Read Teacher Information.

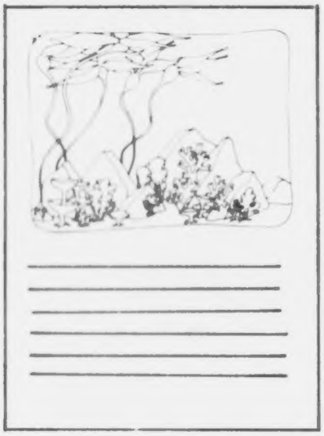
**MATERIALS:**

Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. If possible, show the children large pictures of seaweeds. Ask the children to describe the seaweeds. Write their observations on the blackboard. Have they seen seaweeds? Where? What did the seaweeds look like? What do seaweeds feel like?

2. Read, "The Seaweed Forest "

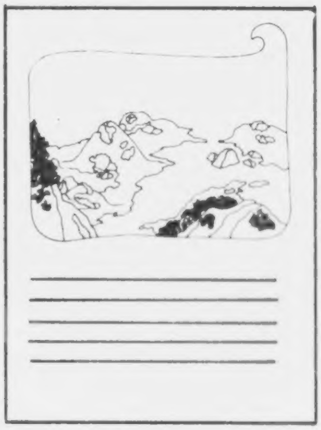


The seaweed forest
at high tide.

3. Possible questions for discussion:
   A. What are seaweeds? [Plants that live in the ocean]
   B. What sizes are seaweeds? [Some are very large, some are short and stalky, some are as tall as trees, some cover the rocks in thin blotches.]
   C. What are some names of seaweeds? [Sea lettuce, rockweed, kelp, coral seaweed, cup and saucer]

D. In the story, which seaweed is edible? [Sea lettuce; Tell the children that rockweed and kelp are also edible.]

4. Read, "The Carpet of Tiny Green Plants."



5. Possible questions for discussion:
   A. What forms a carpet on the rocks? [Millions and millions of tiny plants]
   B. What color is the carpet? [Some are brown, some are green]
   C. What does the carpet feel like? [Slippery]
   D. Has anyone touched the slimy carpets (a thin film on the rocks at the seashore)? Tell the children that the slimy plant carpets cover every rock and every living thing at the seashore: seaweeds, barnacles, crabs, seastars, etc. That is one reason why everything at the seashore is slimy to touch. It also makes walking difficult.

6. Optional Brain Buster Question: Show the students pictures of seaweeds, trees, shrubs, flowers, etc. Discuss the following: How are seaweeds in the ocean like trees, shrubs, and plants on land? How are they different? [Similarities: Both require the sun's energy to grow; both require nutrients (mineral); Both require water; both are the food of countless animals. Differences: Seaweeds have holdfasts, rather than roots; seaweeds do not have flowers; land plants are usually some shade of green; seaweeds are various shades of green, brown, purple, red and pink; land plants get nutrients from the soil; seaweeds get nutrients from surrounding seawater.]

Explain that all energy comes from the sun. All plants, including trees, shrubs, flowers, grasses, diatoms, seaweeds, need energy from sunlight to grow.

7. Role-playing Activity

Be seaweeds at high tide. Sway to and fro, to and fro, with the current. As the tide goes out to sea, let your beautiful fronds and stems slowly come to rest on the boulders and rocks.

8. Optional Field Trip Activities

Run your fingers over various seaweeds. What do seaweeds feel like? Why might seaweeds be covered with slime? How are seaweeds attached to rocks? Draw a picture of three different kinds of seaweeds and show how they are attached to rocks.

9. Uses of Seaweeds

Tell the children that many seaweeds are harvested and used in ice cream, puddings, salad dressings, syrups, and candy bars.

## SEAWEEDS

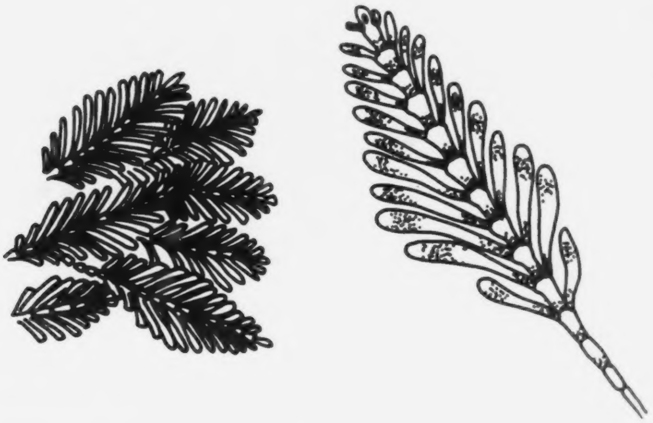
Seaweed life under the sea is as varied and interesting as the animal life. So at low tide, take time to enjoy the colors, textures, and patterns of the seaweeds woven into a patchwork quilt of browns, greens, reds and purples.

The conspicuous rockweeds grow in bushy clumps, lying flat across the rocks or hanging down in curtains, keeping the wetness in and under them when the tide goes out.

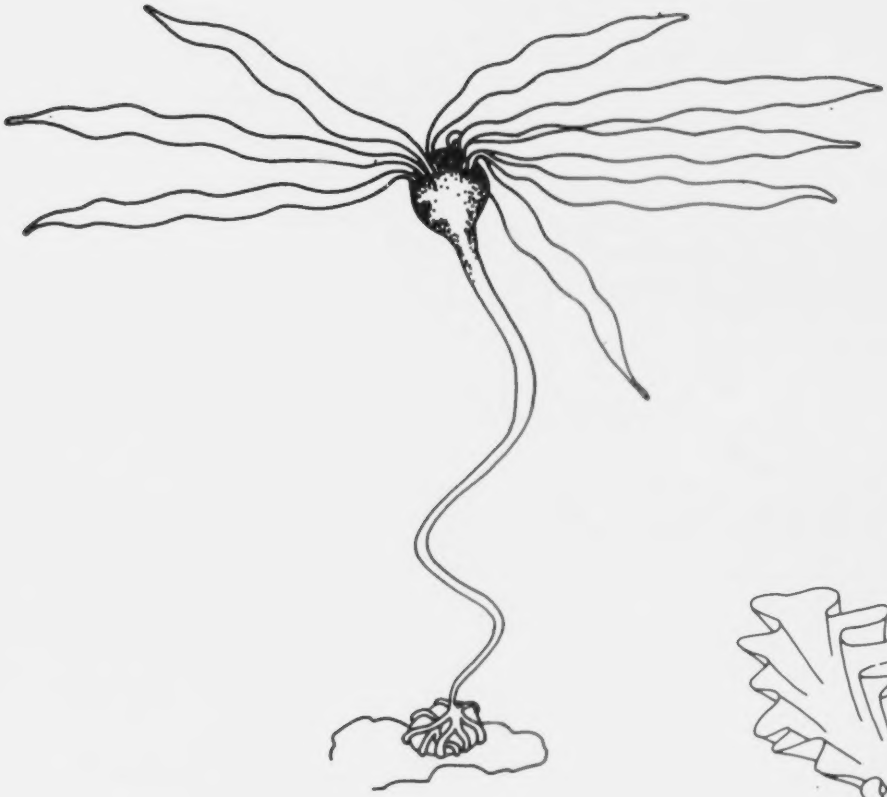
Just below the rockweeds a bright emerald-green seaweed called sea lettuce, looks like leaf lettuce with thin wide wrinkled fronds. You can eat raw sea lettuce after washing it in fresh water to remove the strong salty taste.

A coral seaweed that encrusts the rocks and looks like peculiar splotches of reddish-pink or purplish paint is rock crust. The rough hard rock crust also covers the shells of snails, limpets, and other hard-shelled animals. Difficult to think of them as seaweeds? They are, but made of calcium, the same material as in seashells, teeth, and bones.

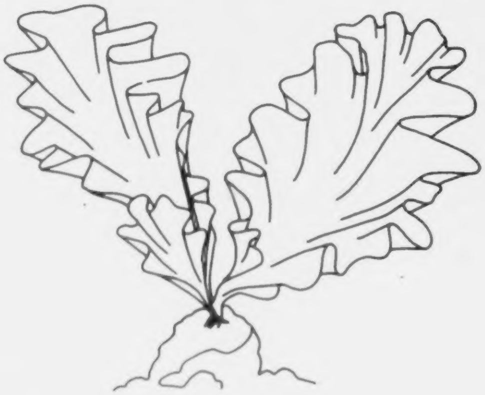
When the tide drops very low on the shore a group of large brown seaweeds come into view. Probably the best known is bulb kelp, a floating bulb, with several long, thin blades rising from the bulb. Off almost any rocky shore there will be great beds of it, but the tides rarely fall far enough to see the large branching holdfasts (root systems).



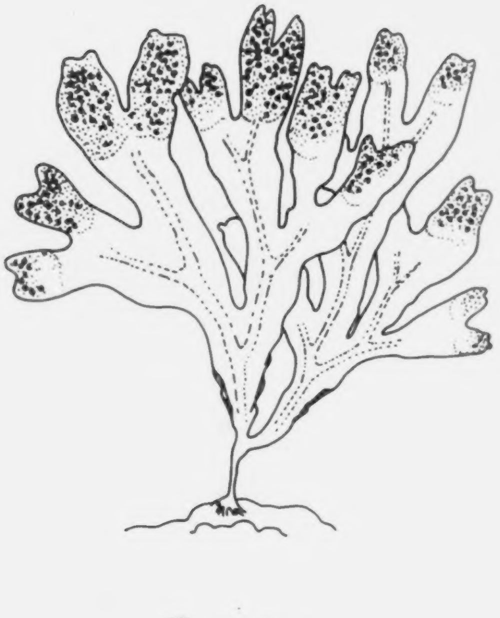
GRACEFUL CORAL SEAWEED



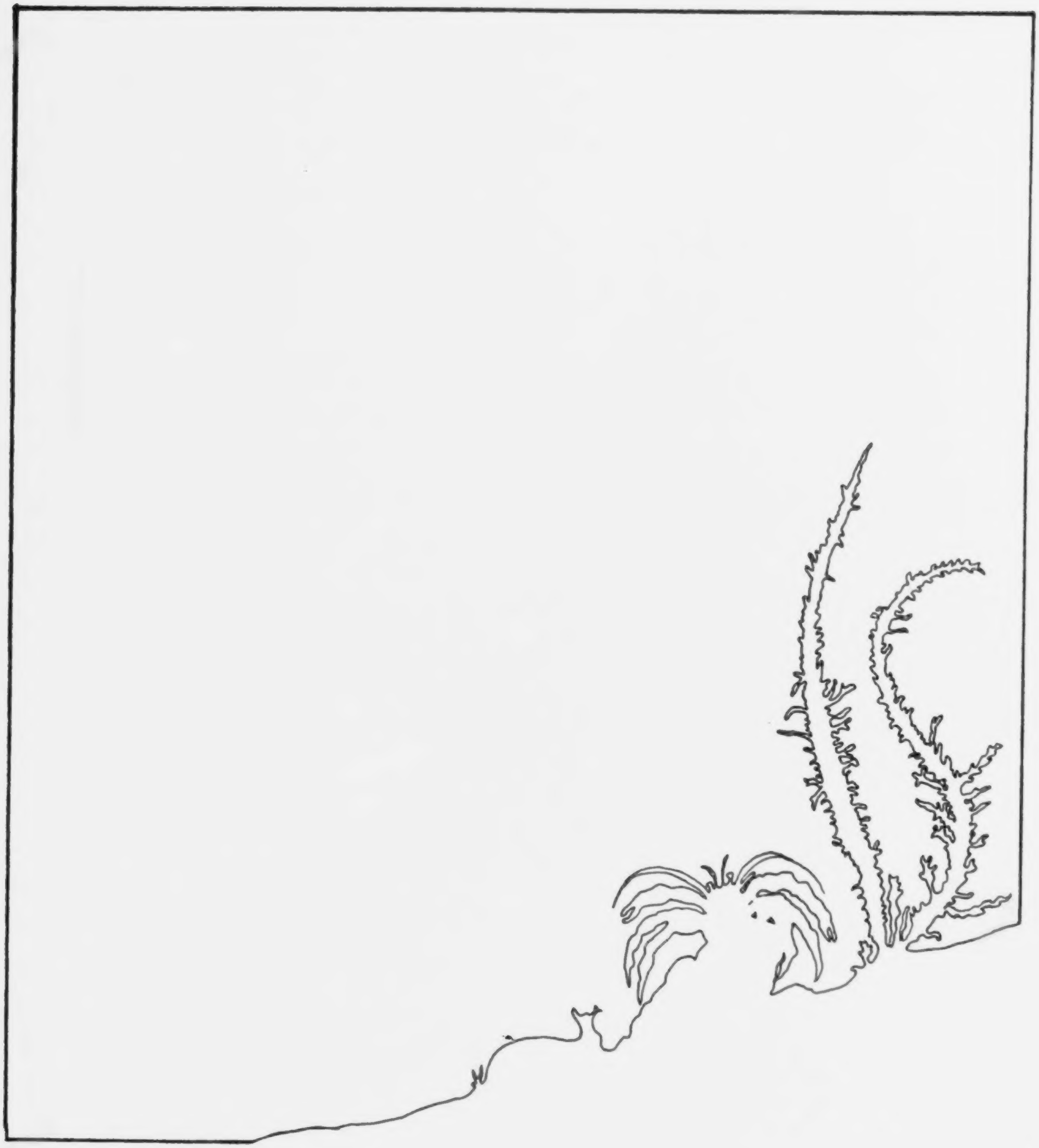
BULL KELP



SEA LETTUCE



ROCKWEED



# ACTIVITY 5:
# SEAGULLS
# (2 DAYS)

# ACTIVITY 5: SEAGULLS (2 DAYS)

**CONCEPTS:**

1. At high tide, seagulls sit and preen their feathers or pace back and forth waiting for the tide to drop.
2. At low tide, seagulls flock to the low tide line to pick and probe with their long sharp bills for whatever edible items they can get.

**OBJECTIVES:**

The children will be able to:

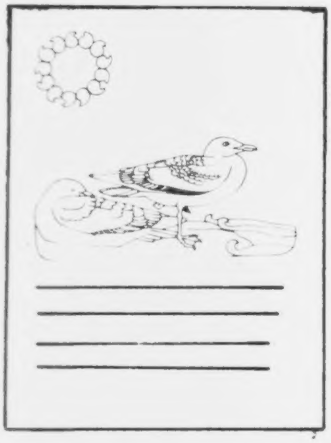
1. describe how seagulls behave at high tide and low tide.
2. role-play how seagulls behave at high tide and low tide.

**TEACHER PREPARATION:** Read Teacher Information.

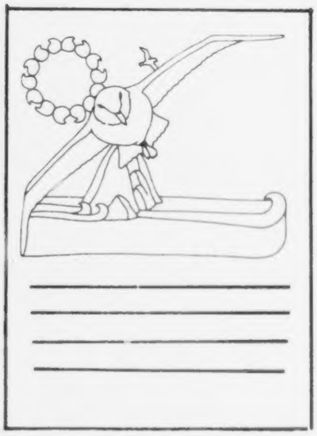
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read, "Seagulls at High Tide" and "Seagulls at Low Tide."



Seagulls at high tide.



Seagulls at low tide.

2. Possible questions for discussion:

Seagulls at High Tide

A. What do adult seagulls look like? [They have clean white heads, pale gray backs and long curved yellowish bills with a bright red spot at the tip.]

B. What do younger gulls look like? [Younger gulls wear dull mottled baby brown suits.]

C. What do seagulls frequently do at high tide? [They sit half asleep in the sunlight and preen (clean) their feathers.]

D. Brain Buster Question: Why do seagulls wait for the tide to drop? [To feed on seashore creatures that at high tide are covered with seawater.]

Seagulls at Low Tide

A. What do seagulls do as the tide drops? [They pace back and forth, along the walls of rock.]

B. What do seagulls eat? [Almost anything or live fish, dead fish, small crabs, snails, mussels, clams, worms, even garbage]

C. List three ways seagulls catch food. [They pick and probe with their long sharp bills; they harass other shorebirds to cough up their catch; they fly into the air and drop mussels on rocks.]

3. Introduce the words "predator" and "prey." Tell the students that any animal that eats another animal is called a "predator." Any animal eaten by another animal is a "prey." Seagulls are predators when they feed on crabs, mussels, clams, etc. As the students read "High Tide, Low Tide" and explore the seashore keep a list of predator and prey animals (optional).

4. Role-playing Activities

On a sandy beach, grassy playground, gym or classroom with desks pushed back, have the students sit in a large circle on the floor. Ask them to close their eyes and think about the story: "Seagulls at High Tide" and "Seagulls at Low Tide." What did the seagulls do at low tide? Tell the students to use their imagination to dramatize what seagulls do at low tide. Ask for 3 or 4 volunteers to dramatize seagulls at low tide. Some groups enjoy clapping after each performance. Ask the students to close their eyes again. Tell them to imagine how they would dramatize seagulls at high tide. Ask for 3 or 4 volunteers.

Tell the students to use their imaginations and dramatize the following scenes:

A. Be seagulls sitting half asleep in the sunlight. Preen your snow-white feathers in the sunlight.

B. Be hungry seagulls pacing back and forth, back and forth, along the wall of rock as the tide goes out.

C. Be hungry seagulls at low tide. Trip down to the low tide line. Pick and probe with your long sharp bill in the cracks, crevices, and seaweeds for something good to eat.

D. Be seagulls squabbling and fighting and harassing other shorebirds to cough up their catches.

5. Creative Writing Activity

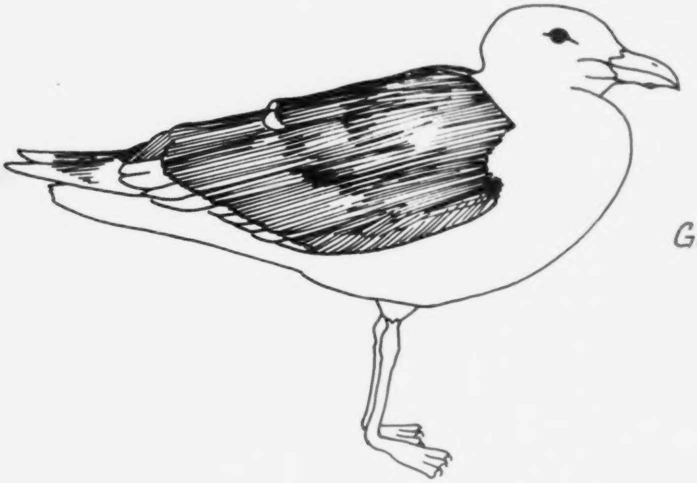
Pretend you are a seagull preening your snow white feathers, waiting for the tide to go out to sea. What happens?

6. Optional Field Trip Activities

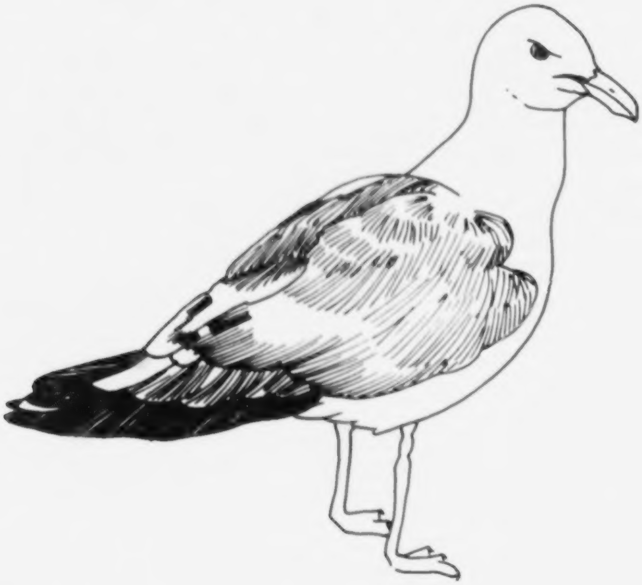
Watch seagulls at the seashore. What are the seagulls doing? What are the seagulls eating? How could you find out? Watch one seagull for fifteen minutes. Keep a record of what the seagull does.

## SEAGULLS

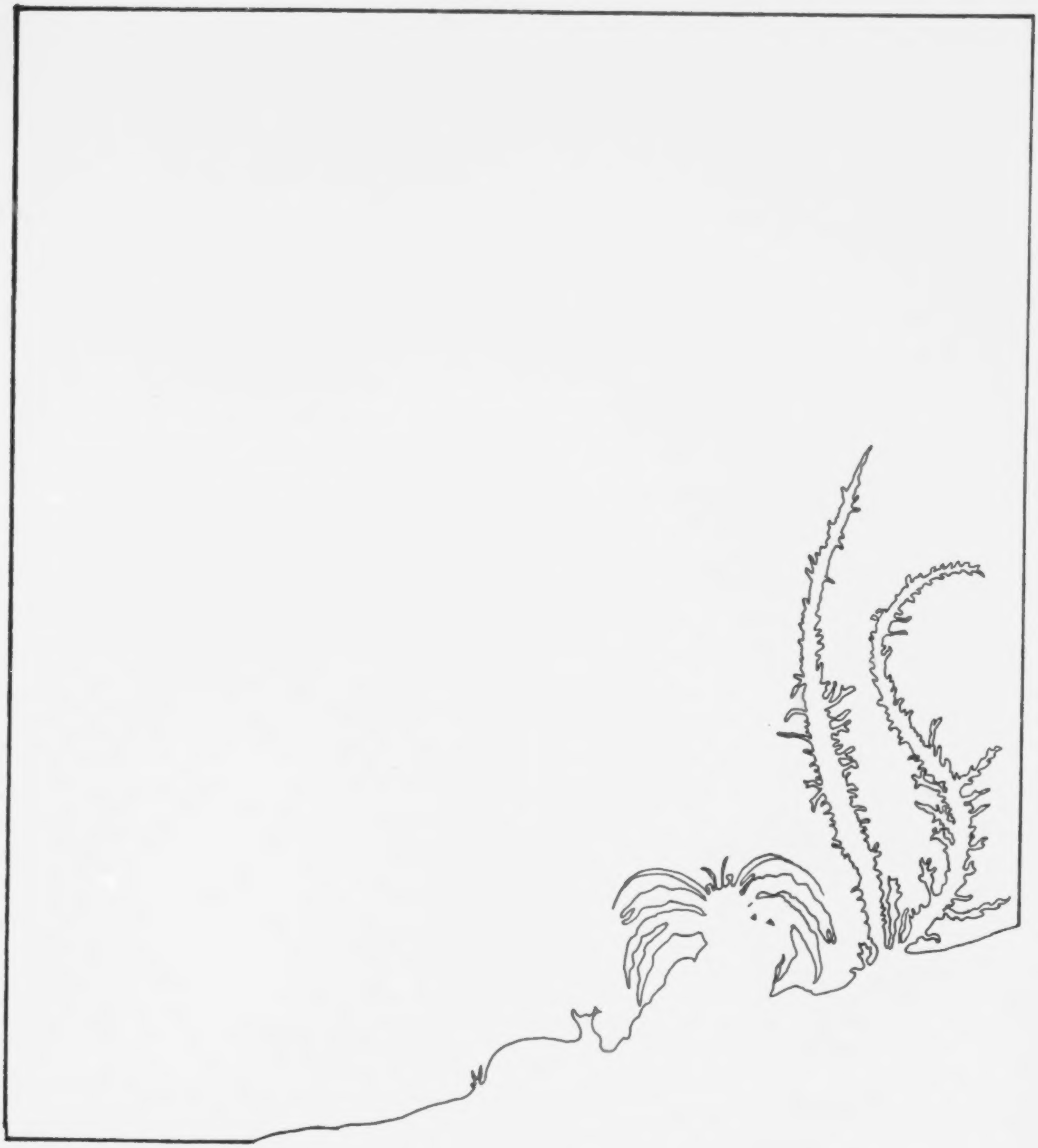
With the ebbing of the tide comes a drama: the seagulls that sit half asleep on the rocky crags stir to life and begin probing with their bills in the cracks, crevices, and seaweeds for small snails, crabs, and worms. Trying to distinguish one juvenile gull from another would result in confusion even for the seasoned bird watcher, because each species usually undergoes first, second, and third year plumage changes and stages of several species closely resemble those of another.



GLAUCOUS-WINGED GULL



HERRING GULL



# ACTIVITY 6:
# BARNACLES
# (3 DAYS)

## ACTIVITY 6: BARNACLES (3 DAYS)

**CONCEPTS:**

1. At high tide, barnacles feed by sweeping the water for microscopic plants and animals (plankton soup).
2. At low tide, barnacles close up tightly to protect themselves from shore predators and from drying out.

**OBJECTIVES:**

The children will be able to:

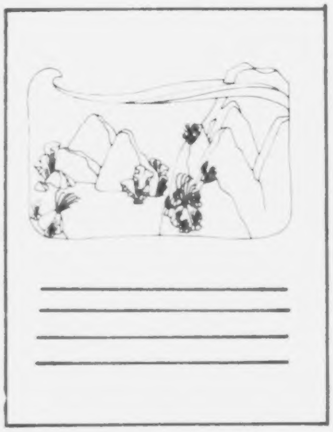
1. describe a barnacle at high tide and at low tide.
2. explain how barnacles feed at high tide.
3. explain how barnacles protect themselves from drying out at low tide.
4. role-play barnacles at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

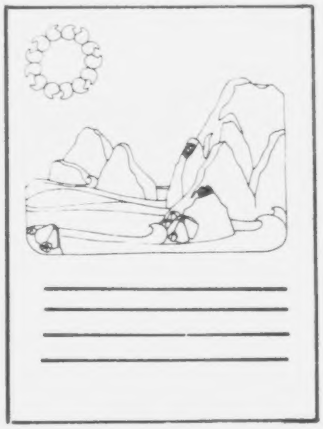
**MATERIALS:** Class set of "High Tide, Low Tide"

**PROCEDURES:**

1. Read, "Barnacles at High Tide" and "Barnacles at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

Barnacles at High Tide

A. What do barnacle shells look like? [Barnacles have gray, volcano-shaped houses made up of six, hard, crusty plates. Some look like thatched fairy castles.]

B. What does the animal inside the shell look like? [A shrimp-like animal that sits upside down with its head cemented to the bottom and its feet pointed towards the top of the shellhouse]

C. How do barnacles eat? [The curled feathery legs make a net, like a fisherman's net. Every second or so the barnacle thrusts out its feather legs to sweep tiny plant and animal plankton down into its mouth.]

D. Do barnacles eat at high tide or at low tide? [When covered with sea water; at high tide, or when submerged in tidepools]

Barnacles at Low Tide

A. What do barnacles look like at low tide? [Stony volcano-shaped barnacles that show no movement or sign of life at all]

B. How do barnacles protect themselves from the bright sunlight? [The six hard crusty shell plates close up tightly. As long as the tide is out, the shellhouse makes a moist chamber and keeps the moisture in.]

C. How do barnacles protect themselves from shore-birds? [They sit inside their hard crusty shells with the six shell plates closed up tightly.]

D. Brain Buster Question: Do barnacles feed during low tide? [No, not if they are out of water. The long feathery legs are curled up tightly inside the shellhouse. However, if a barnacle is in a tidepool, and surrounded by water, it is still able to feed.]

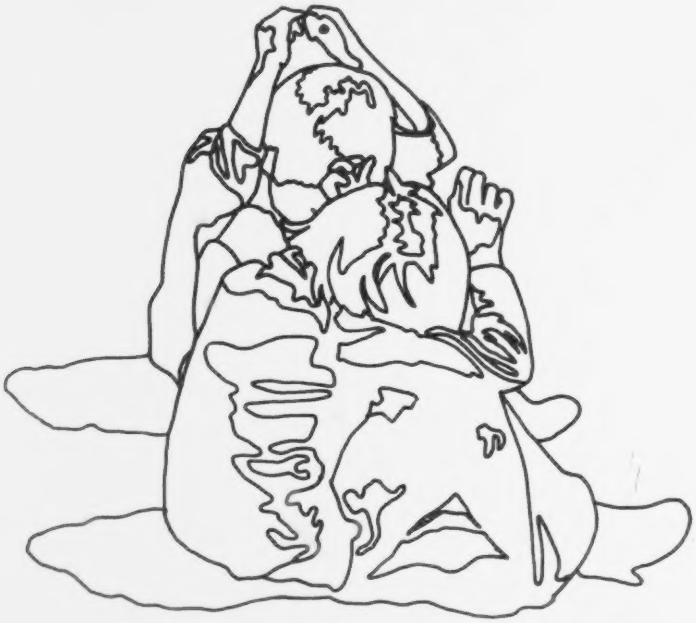
3. Role-playing Activities

A. How many different ways can you make a barnacle? Show me one way. Show me another way.

B. Be a barnacle at high tide. You are a shrimp-like animal that sits upside-down in your shellhouse with your back cemented to a rock. Your feathery legs form a net, like a fisherman's net. Every second or so you sweep the water for plankton soup and kick it down into your mouth.

C. Be a stony volcano-shaped barnacle at low tide. Pull your feathery legs inside and close the six hard crusty shell plates up tightly.

D. Make a barnacle with a partner. Be a barnacle at high tide and at low tide.



Role-playing barnacles at high tide.

4. Creative Writing Activity

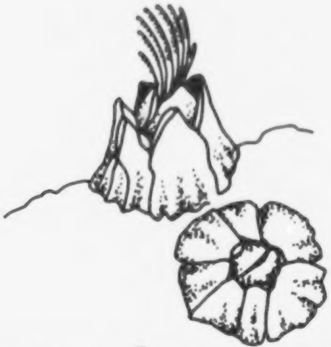
Pretend you are a shrimp-like barnacle that sits upside-down in your shellhouse with your back cemented to a rock. Write a true story telling about your life at the seashore: what you eat, how you protect yourself, what you do at high tide and at low tide. Draw pictures of yourself at high tide and at low tide.

5. Optional Field Trip Activities

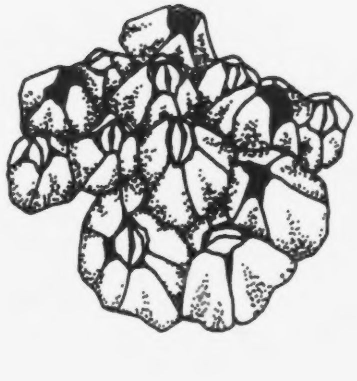
Have fun watching live acorn barnacles under water. Find a small rock covered with barnacles and drop it into a jar of seawater. What happens? What kind of food does the barnacle eat? How does the barnacle get its food? Draw a picture of a barnacle out of salt water. Draw a picture of a barnacle under water.

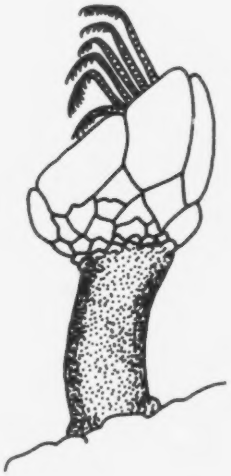
## BARNACLES

On bare exposed rocks, and crowding into the cracks and crevices, are thousands of little barnacles. At low tide they may show no movement or sign of life at all, but when the tide returns and submerges their stony cone-shaped shells, the barnacles thrust a group of feathery plumes in and out. The plume is made up of six feathery legs and works like a net to sweep the water for microscopic food (plankton soup). Barnacle shells consist of a number of plates: some form the volcano-like wall, and the rest, when drawn together, tightly cover the opening to create a protective moist chamber for the soft animal inside. Barnacles regularly molt, or shed their thin inner covering, to allow room for their bodies to grow, and during the spring and summer their clear cast-off skins float in the quiet waters of protected bays.

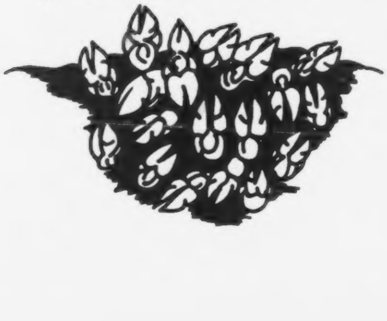


COMMON ACORN BARNACLE





GOOSE-NECK BARNACLE



# ACTIVITY 7: PERIWINKLES (2 DAYS)

# ACTIVITY 7: PERIWINKLES (2 DAYS)

**CONCEPTS:**

1. At high tide, or when covered with seawater, periwinkles move and feed on the carpet of tiny, green plants that covers the rocks.
2. At low tide, or when out of seawater, periwinkles withdraw into their shellhouses.

**OBJECTIVES:**

The children will be able to:

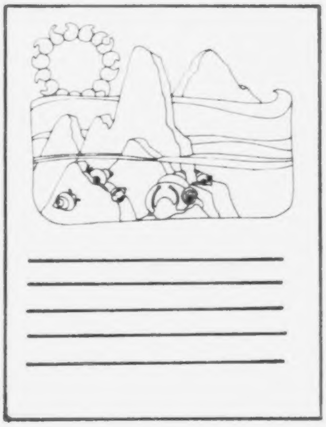
1. describe a periwinkle at high tide and at low tide.
2. explain how periwinkles move at high tide.
3. explain how perwinkles feed at high tide.
4. explain how periwinkles protect themselves from drying out at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

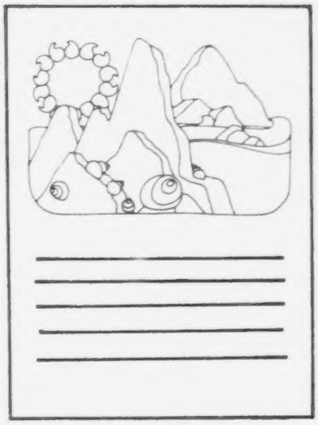
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Periwinkles at High Tide" and "Periwinkles at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

Periwinkles at High Tide

A. What do periwinkles look like? [Dull, gray snails]
B. How do periwinkles move? [They use their strong, flat, muscular foot.]
C. How do periwinkles know where they are going? [They use their pair of eyes and the two long feelers, called tentacles.]
D. What do periwinkles eat? [The carpet of tiny green plants that covers the rocks]

E. How do periwinkles eat? [They scrape the rocks with their tongue that feels like sandpaper.]

Periwinkles at Low Tide

A. What do periwinkles look like at low tide? [Dingy, gray snails that sit motionless on the rocks]

B. How do periwinkles keep from drying out at low tide? [Periwinkles withdraw into their shell-houses and shut the little trap door at the top of the foot. This keeps a moist house.]

C. How do periwinkles protect themselves from shore-birds at low tide? [The coiled shellhouse helps protect the periwinkle from the prying claws of a crab or from the long sharp bill of a shorebird.]

D. Brain Buster Question: How safe are periwinkles at low tide? [They are safe from drying out, but a seagull or other shorebird could easily pry the trap door open with its long, sharp bill, or swallow the periwinkle whole.

3. Role-playing Activities

A. How many different ways can you make a periwinkle? First show me one way. Now show me another.

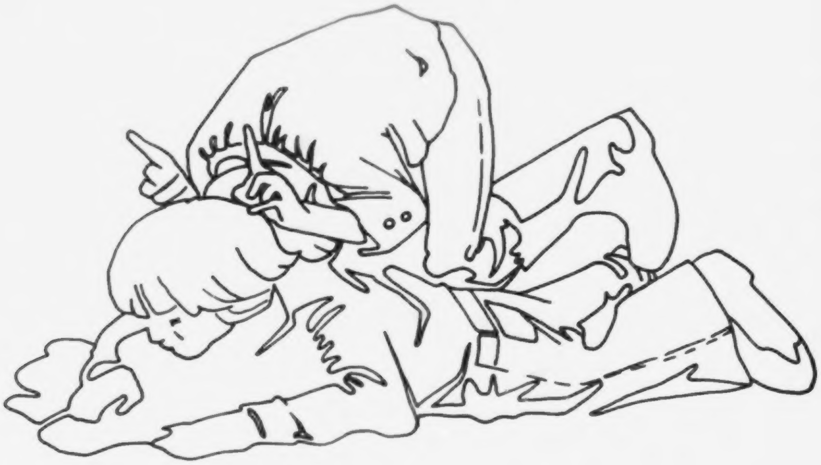
B. Be a dingy, gray periwinkle at high tide. Use your wide muscular foot to travel. The two long tentacles tell you where you are going. Feel the coiled, gray shell wiggle and waddle as you slowly creep along.

C. Be a periwinkle feeding at high tide. Use your sandpaper tongue to scrape the rocks to feed on the thin carpet of tiny green plants.

D. Be a dingy, gray periwinkle at low tide. Pull your flat muscular foot, the two long tentacles and your entire body deep into your coiled shell-house. Now seal your house shut by closing the little bony plate at the tip of your foot, like a trap door.

E. Make a periwinkle with a partner. How many different ways can you make a periwinkle with a partner? Be a periwinkle at high tide and at low tide.

E. Make a periwinkle with a partner. How many different ways can you make a periwinkle with a partner? Be a periwinkle at high tide and at low tide.



Become a periwinkle at high tide.

4. Art Activities

A. Draw a picture of a periwinkle feeding. Show its wide, muscular foot, the coiled shellhouse, and the two long tentacles.

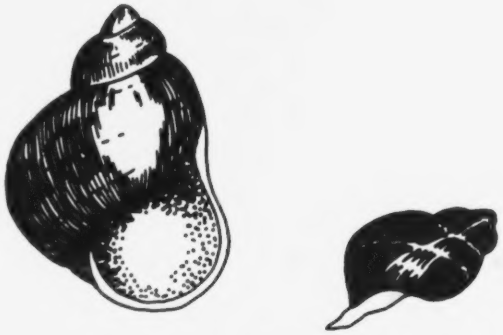
B. Draw a picture of a periwinkle withdrawn deep into its shellhouse. Show how the periwinkle seals its house shut by closing the little trap door at the tip of its foot.

5. Optional Field Trip Activities

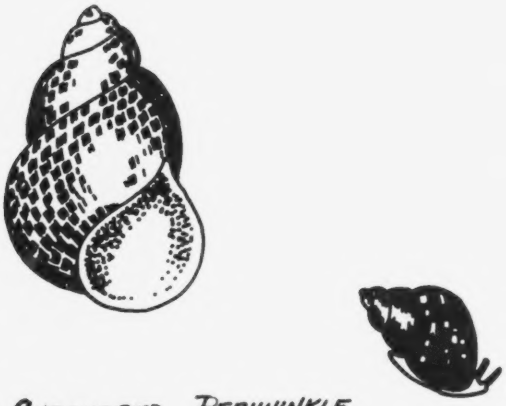
How do periwinkles move? Put some into a glass jar filled with seawater and watch them move up the sides. Watch how the mouth moves as the snail moves. What is the snail doing? Watch the long feelers on the snail. Gently poke the feelers. What happens? Why? How many different ways does the snail use its long feelers? How far can periwinkles travel in one minute? Have a snail race using different kinds and sizes of snails as contestants. Compare snails with limpets.

## PERIWINKLES

At the seashore, look in cracks and crevices and tidepools just below the black band of lichens where whole herds of small, dingy snails crowd together. These periwinkles stay as far away from the sea as possible, only occasionally coming barely close enough to wet their gills. Like all snails, they have an operculum, a hard bony plate at the tip of the foot; it closes like a trap door to create a moist home for the snail sealed inside its shell. Periwinkles move by slowly advancing one part of their strong, flat muscular foot and then pulling the rest after it in a sort of wavy motion. They feed on the thin film of algae and diatoms that covers the rocks. Their tongue, or radula, is a remarkable structure with its many rows of sharp, curved teeth. As the snail scrapes its food from the rocks, old teeth are worn down, but new ones are always ready to be rolled up from behind to take their place.



SITKA PERIWINKLE



CHECKERED PERIWINKLE

# ACTIVITY 8:
# MUSSELS
# (2 DAYS)

## ACTIVITY 8: MUSSELS (2 DAYS)

**CONCEPTS:**

1. At high tide, or when covered with seawater, mussels open their two shells and feed on plankton soup.
2. At low tide, or when out of seawater, mussels close up tightly.

**OBJECTIVES:**

The students will be able to:

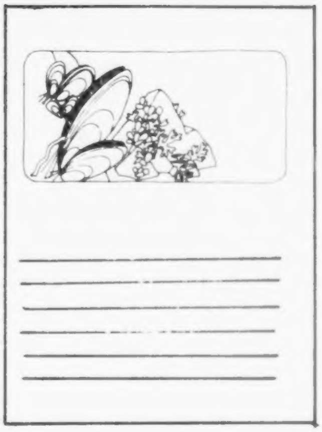
1. describe a mussel at high tide and at low tide.
2. explain how mussels attach to rocks and move.
3. explain how mussels protect themselves from drying out at low tide.
4. role-play mussels at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

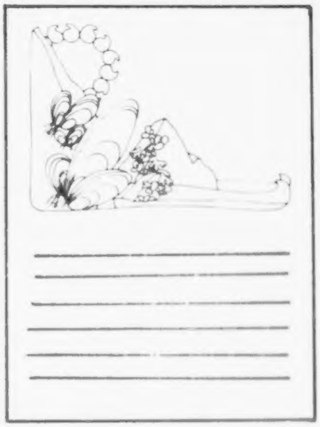
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Mussels at High Tide" and "Mussels at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

   Mussels at High Tide

   A. What do mussels look like? [Each blue mussel has two handsome, heavily ribbed shells, held together by an elastic hinge.]
   B. How do mussels attach to rocks? [Each mussel spins its own long elastic anchor threads to attach itself to rocks and other mussels.]
   C. What do mussels eat? [Plankton]
   D. How do mussels eat? [At high tide, mussels open their two shells and strain plankton from seawater.]

Mussels at Low Tide

A. What do mussels look like at low tide? [Blue mussels sit statue-still in the sunlight, as if showing off their heavily ribbed shells of blues, blacks, and browns.]

B. How do mussels protect themselves from drying out at low tide? [They pull the long thin foot inside and shut the tightly fitting shells together at the hinge.]

C. Brain Buster Question: Are mussels safe from sea stars at low tide? [Yes. Mussels are safe from sea stars because at low tide, sea stars are unable to move easily. Tell the students that if a sea star gets its stomach inside a mussel before the tide drops, the feeding may continue even during low tide periods.]

D. Brain Buster Question: Are mussels safe from sea gulls at low tide? [No. A seagull can swoop down and pry a mussel loose from its anchor threads with its long, sharp bill.]

3. Role-playing Activities

A. How many different ways can you make a mussel?

B. Be a mussel at high tide. Open those two large shells slightly and feed on plankton soup.

C. Be a mussel at low tide. Pull your long thin foot inside and close up tightly. Now sit statue-still in the sunlight, as if showing off that towering twin-shelled house.

D. Make a mussel with a partner. Be a mussel at high tide and at low tide.

E. Work with a partner. Be a mussel that spins a net of tightly strung rope to anchor your shellhouse to the rocks.

F. Work with a partner. Be a mussel that slowly, very slowly, moves along. Open your two shells slightly and use your long slender foot to break the anchor threads. Move very slowly and when you wish to stop, use the long foot to reach out and spin new threads.

4. Art Activities

   A. Draw a picture of a mussel feeding at high tide.

   B. Draw a picture of a mussel closed up tightly at low tide.

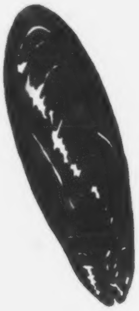
5. Optional Field Trip Activity

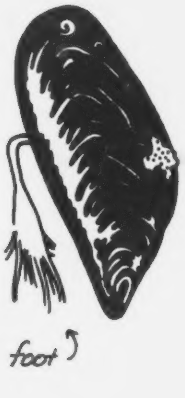
   How do mussels attach to rocks? Draw a picture of a mussel attached to a rock. Do mussels move? Are you sure? Put some in a bucket of seawater overnight to see what happens.

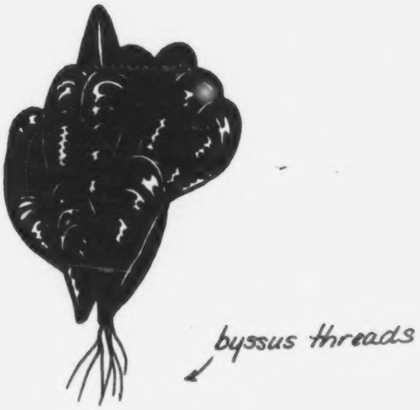
# MUSSELS

High on rocky shores, either clumped together or sharing spaces with the barnacles, lie great beds of mussels; bivalves with two shells hinged together by an elastic ligament. They attach themselves to rocks and to each other with long elastic threads called "byssus threads" which allow the mussels to cluster together in holes and in crevices until masses hang down over the rocks. Mussels move very slowly, the byssus and the foot working together. Like the barnacles, mussels are filter feeders and during high tides open their shells and filter the water for microscopic food.

BLUE MUSSELS







# ACTIVITY 9:
# LIMPETS
# (2 DAYS)

## ACTIVITY 9: LIMPETS (2 DAYS)

**CONCEPTS:**

1. At high tide, or when covered with seawater, limpets feed on the carpet of green plants that covers the rocks.
2. At low tide, or when out of seawater, limpets plaster themselves to the rocks with a very strong suction.

**OBJECTIVES:**

The children will be able to:

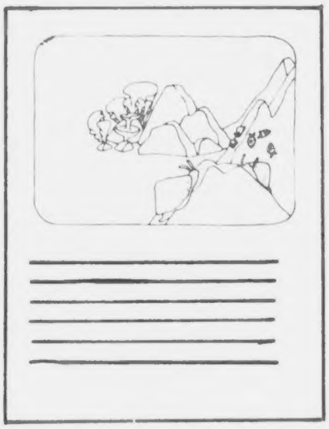
1. describe limpets at high tide and at low tide.
2. explain how a limpet uses its foot to move at high tide.
3. explain how a limpet feeds at high tide.
4. explain how a limpet protects itself from drying out at low tide.
5. role-play limpets at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

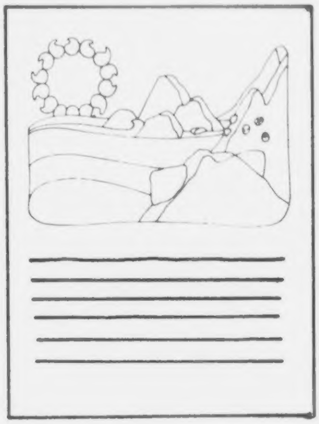
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read, "Limpets at High Tide" and "Limpets at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

   Limpets at High Tide

   A. What do limpets look like? [They are cone-shaped animals that look like tiny Chinese hats; usually brown or gray and speckled with white dots.]
   B. How do limpets move? [Limpets have a wide, muscular foot which they use when traveling.]
   C. What do limpets eat? [They use their tongue of fine sandpaper to scrape on the thin carpet of tiny green plants that covers the rocks.]

D. Do limpets eat at high tide or at low tide? [When they are covered with sea water; at high tide or as long as they are in tidepools]

Limpets at Low Tide

A. What do limpets look like at low tide? [Like little armored tanks, having run out of gas]
B. How do limpets protect themselves from drying out at low tide? [They pull their head and the two long tentacles inside their shell and plaster themselves to the rocks with a very tight suction.]
C. Do limpets feed at low tide? [When out of seawater, limpets stop scraping the rocks for the tiny green plants, but those in tidal pools continue feeding.]
D. Brain Buster Question: Are limpets safe from crabs, sea stars, and shorebirds at low tide? [They are safe from crabs and sea stars, but some shorebirds are quite capable of prying them off at low tide. Tell the children that Oyster Catchers are shore birds with a chisel-shaped bill for prying open oysters, clams, and snails and for prying limpets from rocks.]

3. Role-playing Activities

A. How many different ways can you make a limpet? Show me one way. Now show me another way.

B. Be a cone-shaped limpet at high tide. Use your wide muscular foot for traveling, the two long tentacles for feeling, and the sandpaper tongue for scraping the thin film of green plants from the rocks.

C. Be a speckled limpet at low tide. Pull your head and the two long tentacles inside your cone-shaped shell. Plaster your foot to the rock to make a tight suction.

D. Make a limpet with a partner. Be a limpet at high tide and at low tide.

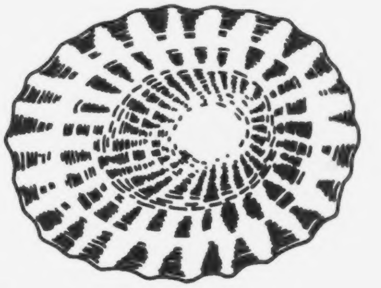
4. Art Activities

A. Draw a picture of a limpet at high tide.

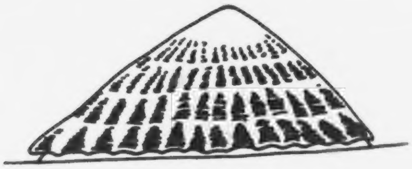
B. Draw a picture of a limpet at low tide.

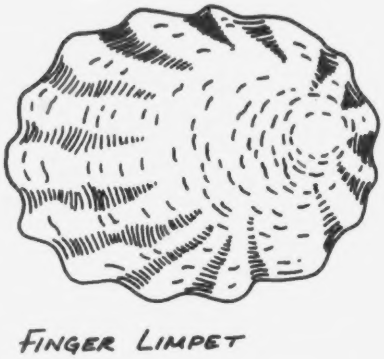
## LIMPETS

Crowding into the crevices, holes and tidepools are groups of limpets that look like minature chinese hats. Like their relatives the snails, limpets have a muscular foot which they extend when traveling. If the tide is out, they plaster themselves against rocks with a suction so tight that once they have taken hold, prying them off may take a force of up to 32 to 36 kg (70 - 80 lbs.). This ability to hold fast to rocks protects the limpets from wave shock and predators and insures a moist chamber inside the shell. Limpets use their specialized tongue, or radula, to scrape the thin film of algae and diatoms that covers the rocks. Some limpets feed on seaweeds.

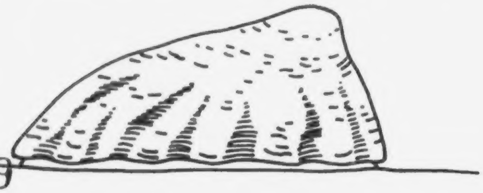


SHIELD LIMPET





FINGER LIMPET



# ACTIVITY 10:
# SHORE CRABS
# (2 DAYS)

# ACTIVITY 10: SHORE CRABS (2 DAYS)

**CONCEPTS:**

1. At high tide shore crabs scurry across the rocks or creep among gently swaying seaweeds looking for food.
2. At low tide shore crabs move into tidal pools or hide under rocks or sheltered rock crevices.

**OBJECTIVES:**

The children will be able to:

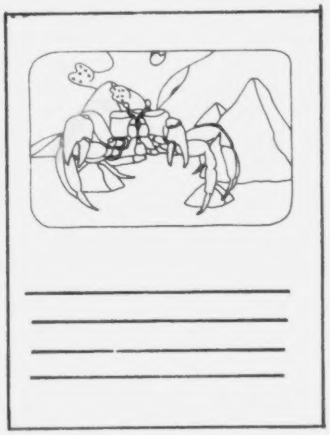
1. explain how shore crabs move.
2. explain how shore crabs eat.
3. list at least three things shore crabs eat.
4. explain how shore crabs protect themselves from the drying sun at low tide.
5. explain how shore crabs protect themselves from shore predators at low tide.
6. role-play shore crabs at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information

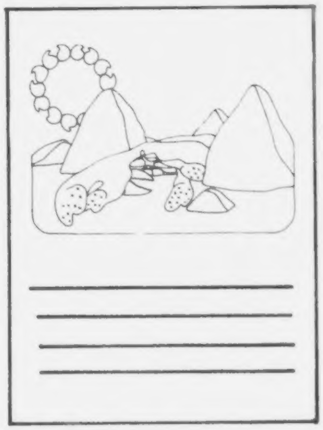
**MATERIALS:** Class set of "High Tide, Low Tide"

**PROCEDURES:**

1. Read "Shore Crabs at High Tide" and "Shore Crabs at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

   Shore Crabs at High Tide

   A. What do shore crabs look like? [They have a thick armor-like covering (carapace), and two heavy claws.]

   B. How do shore crabs move? [They travel equally well forwards, sideways, and backwards.]

C. How do shore crabs protect themselves from other shore creatures? [By their armor-like covering and two heavy claws]

D. What do shore crabs eat? [Whatever they can find; including dead and dying plants and animals]

E. Brain Buster Question: Shore crabs are said to provide a helpful service at the seashore. What service do they perform? [They act as a garbage disposal crew by removing unwanted waste from the seashore.]

Shore Crabs at Low Tide

A. How do shore crabs protect themselves from drying out at low tide? [They hide among moist seaweeds or scurry into sheltered rock crevices, crawl under large rocks, or creep into tidal pools.]

B. Why do shore crabs fold their two heavy claws in front of themselves? [To close the entrance to their under-rock shelters. This helps keep the moisture and coolness in and protects them from predators.]

C. Are shore crabs safe from the hungry gulls that search the shore for food? [As long as shore crabs remain hidden, they are fairly safe from the long, sharp bills of the seagulls.]

3. Role-playing Activities

A. How many different ways can you make a shore crab? First try one way. Then try another way.

B. Walk like a shore crab: forwards, backwards, and sideways.

C. Eat like a shore crab. Use those two heavy claws to break open a barnacle's shellhouse and take the food to the mouth. Use the six pairs of moveable mouth parts to tear and crush the food before it enters the mouth.

D. Be a purple shore crab at low tide. Crawl sideways into narrow passageways or dig backwards under large rocks. Fold the two heavy claws in front of you to seal the entrance to your under-rock shelter.

E. Make a shore crab with a partner. Make the shore crab move. Be a shore crab at high tide and low tide.

F. Work in groups of 3, 4, 5, or 6. Be shore crabs hiding under a rock at low tide. Suddenly a school student turns over the rock. What happens?

4. Creative Writing Activities

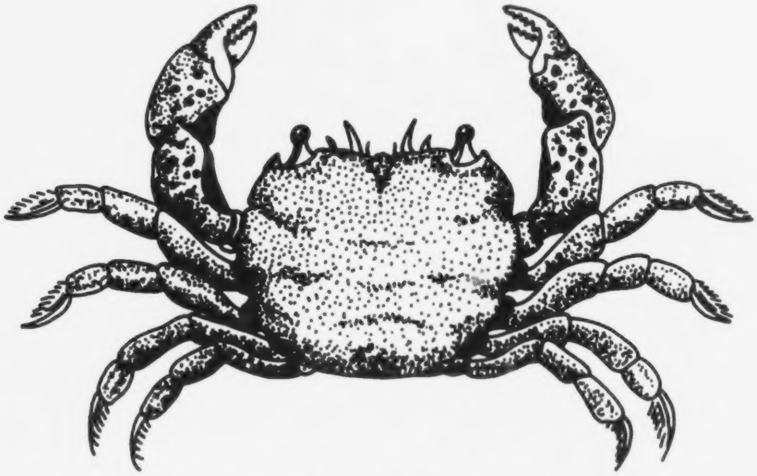
Pretend you are a shore crab. Tell about your life at the seashore; how you get food, protect yourself from predators, and live in an under-rock shelter.

5. Optional Field Trip Activities

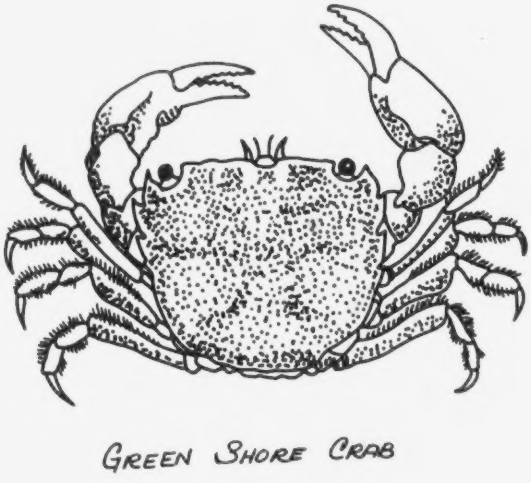
Find a shore crab that is eating. Watch how the crab eats. Draw a picture of a crab eating. Watch how it moves. Move like a crab. Why do crabs move sideways? Investigate to find out.

## SHORE CRABS

On most rocky shores, watch the hundreds of shore crabs scramble to hide under the rocks. Shore crabs have a more or less flattened body, with a hard outside skin called a carapace. They can move in any direction at once, but due to the formation of their jointed legs, they generally move sideways. They eat almost anything they can find, including dead and dying sea life. Together with other scavengers they recycle waste matter and act as garbage disposal systems by removing dead and dying organisms from the seashore.



PURPLE SHORE CRAB



GREEN SHORE CRAB

# ACTIVITY 11:
# SEA STARS
# (2 DAYS)

## ACTIVITY 11: SEA STARS (2 DAYS)

**CONCEPTS:**

1. At high tide, or when covered with seawater, sea stars move easily about in search of food.
2. At low tide, or when out of seawater, sea stars stop moving.

**OBJECTIVES:**

The children will be able to:

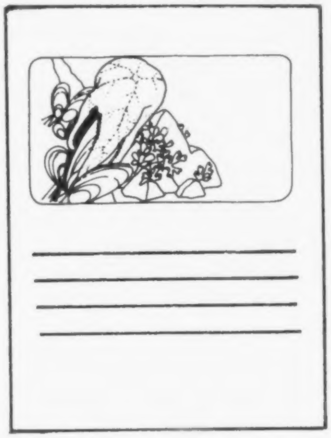
1. describe a sea star at high tide and at low tide.
2. explain how a sea star moves.
3. explain how a sea star eats.
4. explain how a sea star keeps from drying out at low tide.
5. role-play a sea star at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information

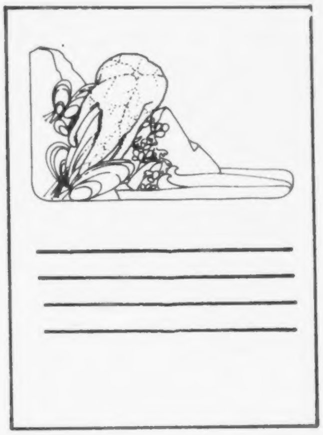
**MATERIALS:** Class set of "High Tide, Low Tide"

**PROCEDURES:**

1. Read "Sea Stars at High Tide" and "Sea Stars at Low Tide"



High Tide



Low Tide

2. Possible questions for discussion:

   Purple or Orange Sea Star at High Tide

   A. Where does the purple or orange sea star live? [On the rocks just below the mussel beds]

   B. How do purple or orange sea stars move? [With their many tube feet. At the tip of each tube foot is a water bulb that forms a suction cup. The tube feet work as plungers and levers to pull and shove the body forward.]

C. How do sea stars eat? [A sea star uses its tube feet to pull the mussel's two shells apart. Then it slips its bag-shaped stomach into the mussel and digests the shellfish right inside its own shell.]

D. Brain Buster Question: What do purple or orange sea stars eat? [Mussels. (Tell the children that sea stars also eat clams, oysters, scallops, and dead and dying animals.)]

Purple or Orange Sea Star at Low Tide

A. Why do sea stars stop moving when the tide is out? [Because they need water to support their large heavy bodies and water to make their arms and tube feet work.]

B. How do sea stars keep from drying out at low tide? [Before the tide goes out, sea stars take in seawater and firmly attach their tube feet to rocks or to whatever they happen to be eating. As long as the tide is out they remain firmly attached and their hard, spiny skins keep the moisture in.]

C. Brain Buster Question: Are sea stars safe from gulls and other shorebirds at low tide? [They are usually quite safe, but occasionally some become stranded by the falling tide. If a sea star is not firmly attached, it is easy prey for gulls and other shorebirds that can pry them loose.]

3. Role-playing Activities

A. How many different ways can you make a sea star? Show me one way. Show me another way.

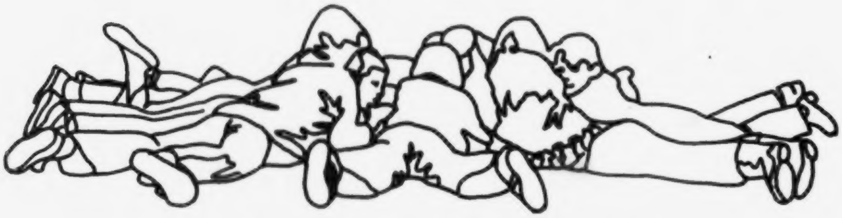
B. Be a sea star at high tide. The surrounding water helps to make your heavy body light. You can easily glide over the rocks using your tube feet to push and pull yourself along.

C. Be a sea star attacking a mussel. Use your tube feet to pull and pull, until the two mussel shells open slightly. Quick as a wink, slip your bag-shaped stomach from yourself into the mussel. You can digest the mussel right inside its own shell.

D. Be a sea star at low tide. Your body is too heavy to glide easily over the rocks. But before the water drops, fill your body with seawater and firmly attach your tube feet to rocks.

E. Work with a partner. How many different ways can you make a sea star with a partner? Make the sea star move.

F. Work in groups of 2 to 5. Make a sunflower sea star move.



Role-playing a sunflower sea star.

4. Optional Field Trip Activities

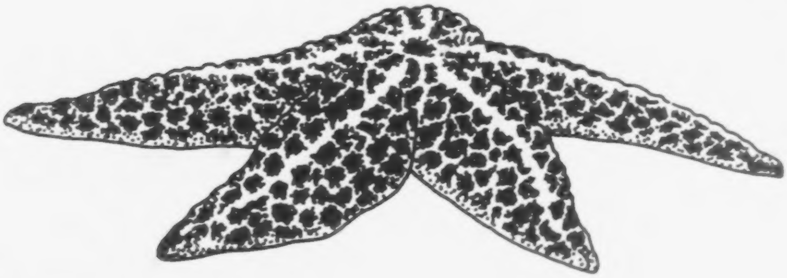
Draw a picture of the top side of a sea star. Draw a picture of the bottom side of a sea star. Watch a sea star moving. How does it move? Draw a picture of a sea star eating.

## SEA STARS

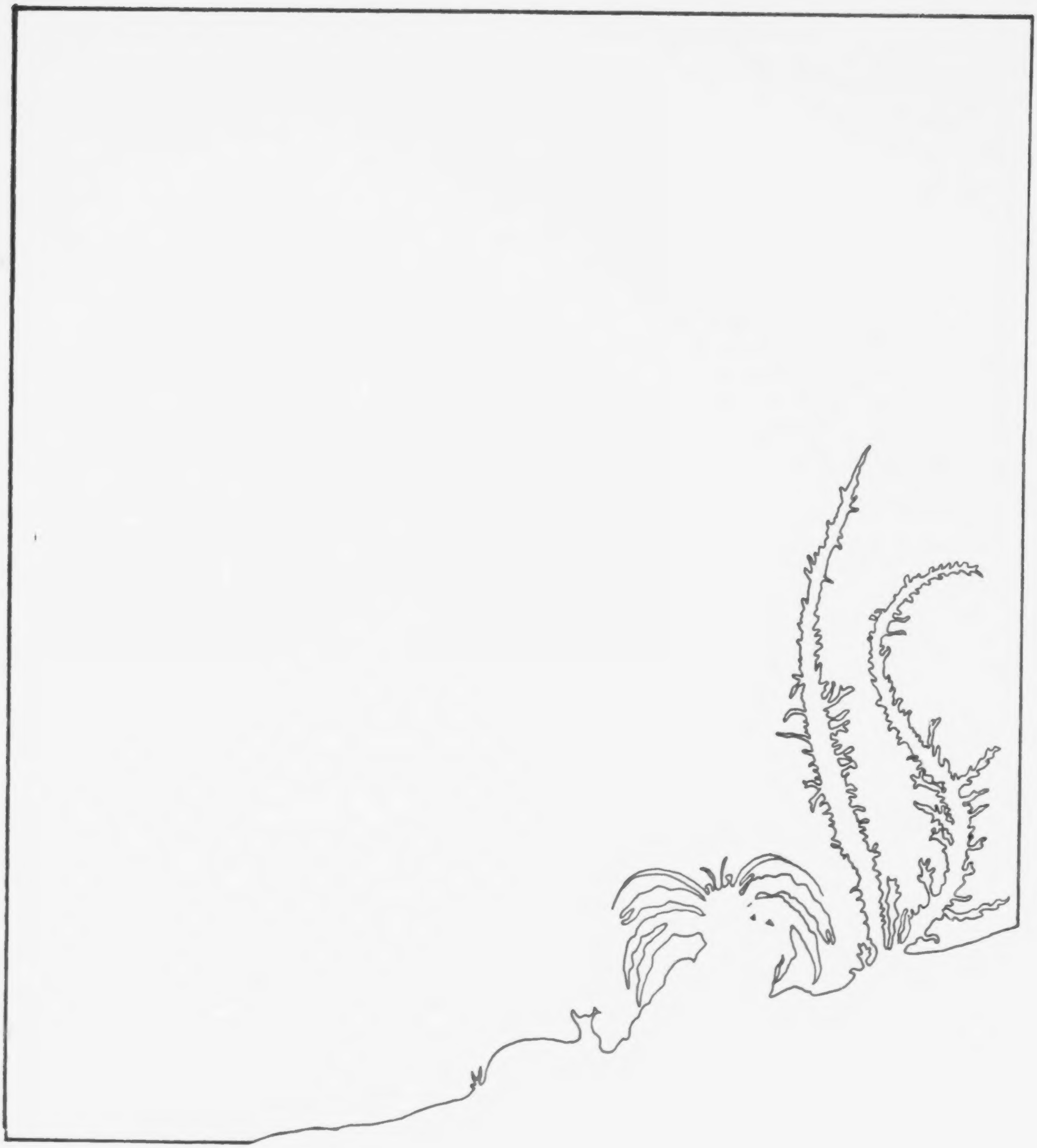
On the rocks just below the mussel beds are many kinds of brightly colored sea stars. By far the most abundant is the Common Purple or Ochre Star. This sea star is harsh to the touch because its body has many blunt limy spines. The color varies greatly: oranges, browns or purples.

Noted for its appetite, the Common Purple or Ochre Star humped up over a clam, mussel, or oyster is probably positioning itself over the shellfish to eat it. When attacking a shellfish, the sea star uses its tube feet to pull and pull until slowly the two muscles holding the shells together begin to tire and start to gap slightly. The sea star quickly slips its stomach from itself into the shellfish; the stomach secretes digestive enzymes, and as the tissues of the prey soften, the sea star extends its bag-shaped stomach farther into the open spaces and digests the animal right inside its own shell. The digestive process may take two or three days.

The ability of sea stars to move and cling onto rocks depends on the operation of the water-vascular system, a highly efficient network of inside plumbing. In a submerged sea star the tube feet alternately extend and contract, attaching to the substrate by suction-cup arrangements at the tips. Special muscles direct the motion of the feet, permitting the animal to move. These tube feet work as suction cups and as levers to pull and shove the body forward.



PURPLE OR ORANGE SEA STAR



# ACTIVITY 12:
# TIDEPOOL SCULPINS
# (2 DAYS)

# ACTIVITY 12: TIDEPOOL SCULPINS (2 DAYS)

**CONCEPTS:**

1. At high tide, tidepool sculpins glide from rock to rock gobbling up food.
2. At low tide, sculpins either swim out to sea with the outgoing tide, or become stranded in tidal pools.

**OBJECTIVES:**

The children will be able to:

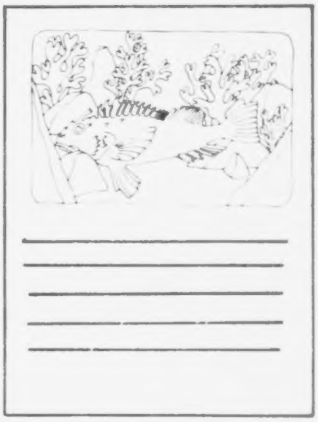
1. describe a tidepool sculpin.
2. describe how a tidepool sculpin moves.
3. list three things a tidepool sculpin eats.
4. role-play a tidepool sculpin at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

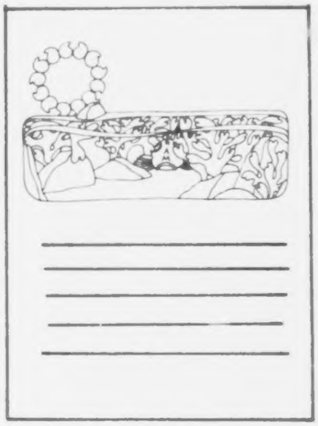
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Tidepool Sculpins at High Tide" and "Tidepool Sculpins at Low Tide"



High Tide



Low Tide

2. Possible questions for discussion:

   Tidepool Sculpins at High Tide

   A. What do tidepool sculpins look like? [Tidepool sculpins are fish with big heads, large powerful jaws, and long tapering bodies with spiked fins and tails. They are usually shades of black, brown, or green along with some white.]

   B. How do tidepool sculpins move? [They walk along on the forward fins and tail or glide from rock to rock.]

C. Why are sculpins hard to see? [The colors of the tidepool sculpin blend perfectly with the rocks, shadows, and seaweeds of the pool. They can also change their colors to match their surroundings. Tell the children that this ability to blend with the surroundings is called camouflaged.]

D. List three things a tidepool sculpin eats. [Small barnacles, tiny crabs, and snails]

Tidepool Sculpins at Low Tide

A. Where do tidepool sculpins go at low tide? [They either swim out to sea with the outgoing tide, or become stranded in open pools of seawater.]

B. Are tidepool sculpins well camouflaged at low tide? [They can sit on the bottom of the pool in plain sight because they blend beautifully with the rocks, seaweeds, and shadows of the pool.]

C. Are tidepool sculpins safe from shorebirds at low tide? [As long as they hide under stones or among the seaweeds or remain perfectly still on the bottom of the pool they are safe, but should a sculpin move, a seagull could swoop down and pick it up with its long bill.]

3. Role-playing Activities

A. How many different ways can you make a sculpin? Show me one way. Show me another way.

B. Be a tidepool sculpin stranded in a pool of seawater when the tide is out. You can glide easily among the seaweeds, hide under rocks, or sit on the bottom in plain sight. Walk along the bottom on your forward fins.

C. Work with a partner. Role-play a seagull swooping down to snatch up a sculpin sitting on the bottom of a tidepool. What happens?

4. Creative Writing Activities

Tidepool sculpins are said to be "color change artists." Tell about a day in your life; how you find food, change colors, and protect yourself from predators.

5. Art Activities

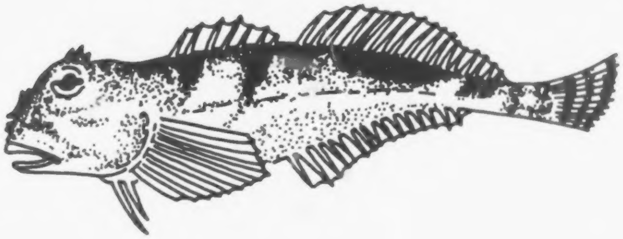
Draw a picture of a tidepool sculpin blending perfectly with the rocks, seaweeds, and shadows of the pool. Color the picture.

6. Inquiry Activity

Put a sculpin in a large jar of seawater. Completely cover the jar with black paper. Wait 15 minutes before removing the colored paper. What color changes have taken place? Try white paper, red paper, mottled paper, etc. What have you learned about Tidepool Sculpins?

## TIDEPOOL SCULPINS

On the bottom of tidepools several very small, strange-looking fish will glide from rock to rock -- Tidepool Sculpins. Their heads are very large for their small tapering bodies, and their large forward fins are frequently used for walking. Well camouflaged, Tidepool Sculpins blend beautifully with the rocks, weeds, and shadows of the pool. The colors vary greatly, but they usually include some shades of black, brown, or green along with some white. Younger ones show more white than do the adults.



# ACTIVITY 13:
# BLENNIES
# (2 DAYS)

## ACTIVITY 13: BLENNIES (2 DAYS)

**CONCEPTS:**

1. At high tide blennies swim with writhing, snake-like movements looking for food.
2. At low tide blennies either swim out to sea with the out-going tide or hide under rocks.

**OBJECTIVES:**

The children will be able to:

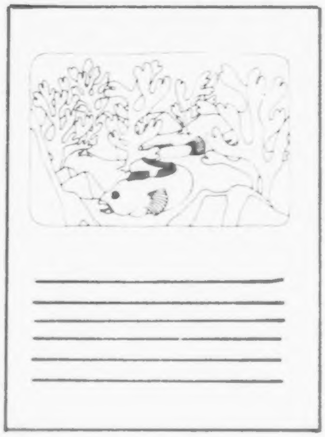
1. describe a blenny.
2. describe how a blenny moves.
3. explain how blennies blend into their surroundings.
4. list at least three things blennies eat.
5. explain how blennies keep from drying out.
6. explain how blennies protect themselves from shore predators at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

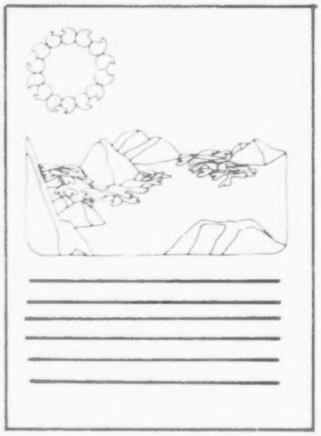
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Blennies at High Tide" and "Blennies at Low Tide."



High Tide



Low Tide

2. Some possible questions for discussion:

Blennies at High Tide

A. What do blennies look like? [A blenny is an eel-like fish with a long, top fin that runs into the tail. Some are a combination of browns, blacks, and greens. Some are decorated with dots and stripes.]

B. Are blennies harmful to humans? [No. Blennies only look like eels. They are harmless fish.]

C. Why are blennies called color change artists? [They can change their colors to match their surroundings.]

D. What other animal is a color change artist? [The tidepool sculpin]

E. How do blennies move? [They swim with writhing snake-like movements.]

F. What do blennies eat? [Blennies eat worms, small crabs and snails, and other small creatures.]

Blennies at Low Tide

A. Where do blennies hide at low tide? [They hide in dark, moist places: among seaweeds, under rocks, or in rock crevices.]

B. Why are blennies covered with a thin coat of slime? [The slime helps keep blennies from drying out and helps them to slither and slide into sheltered hiding places.]

C. Why do blennies hide under the rocks at low tide? [Under-rock hiding places offer safe retreats from the drying sun and from gulls and other shorebirds.]

3. Role-playing Activities

A. How many different ways can you make a blenny?

B. Be a blenny at high tide. Swim snake-like among the seaweeds and shadows of the pool.

C. Be a blenny in a tidepool at low tide. Gobble up small snails, crabs, and other good things to eat.

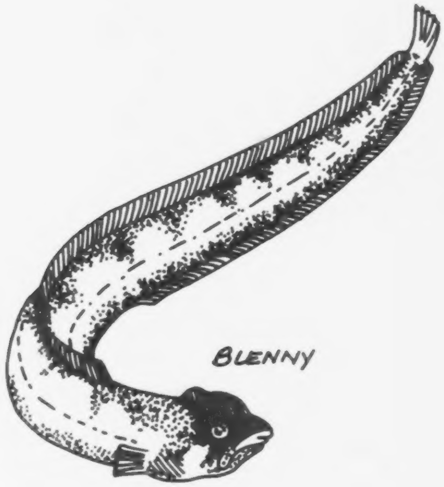
D. Be a blenny stranded on a rocky shore at low tide. Your slimy body allows you to wiggle and squiggle and slither and slide among seaweeds and into under-rock hiding places.

E. Make a blenny with a partner. Be a blenny at high tide and at low tide.

F. Work in groups of 3-5. Be blennies hiding under a rock at low tide. Suddenly, a student turns over the rock. What happens?

## BLENNIES

Under rocks the size of cobblestones, is a group of writhing, eel-like fish called blennies. Their long top dorsal fin runs into the tail and makes the blennies look like eels. The name blenny comes from the Greek word "blenna" which means slime or mucus; they lack scales and thus have a smooth body. Blennies are really not as homely as they might appear at first; some a combination of browns, grays, blacks and greens, with designs or stripes running the length of the body. They sit motionless, but when frightened they can jump out of the water and slither across rocks into other nearby pools.



# ACTIVITY 14: HAIRY HERMIT CRABS (2 DAYS)

# ACTIVITY 14: HAIRY HERMIT CRABS (2 DAYS)

**CONCEPTS:**

1. At high tide, or when stranded in tidal pools, hermit crabs busily move about looking for food or for suitable snail shells.
2. At low tide, or when out of seawater, hermit crabs hide under rocks and withdraw into their snail shells.

**OBJECTIVES:**

The children will be able to:

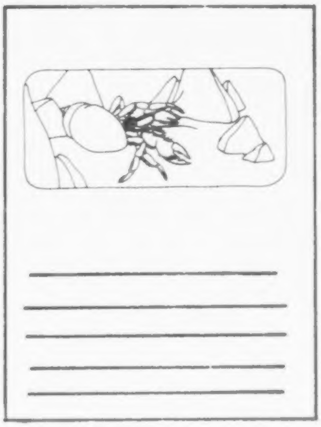
1. describe a hermit crab.
2. explain why hermit crabs live in snail shells.
3. explain how hermit crabs keep from drying out at low tide.
4. role-play hermit crabs at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

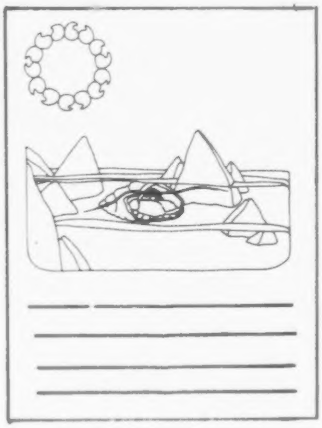
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Hairy Hermit Crabs at High Tide" and "Hairy Hermit Crabs at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

Hairy Hermit Crabs at High Tide

A. What does a hairy hermit crab look like? [It is a funny looking crab with eyes on long, movable stalks, two very long feelers or antennae, six pairs of hairy legs and a soft curled body.]

B. Why do hairy hermit crabs live in empty snail shells? [To protect their soft, curled bodies from hungry seashore creatures]

C. Why do hairy hermit crabs do battle? [As they grow they must constantly find larger shellhouses. Sometimes two hermits have their eyes on the same empty snail shell.]

D. Brain Buster Question: Why do hermit crabs have eyes on long stalks? [So they can see behind their snail shell. So they can see out when they are inside their shell.]

Hairy Hermit Crabs at Low Tide

A. How do hermit crabs protect themselves at low tide? [They pull their soft curled bodies, the two long antennae, and the six pairs of walking legs deep into their mobile snail homes.]

B. How do hermit crabs use their hook-like legs? [They use hook-like legs for holding onto the shellhouse.]

C. Brain Buster Question: When a hermit crab is inside its shellhouse it uses its large claws for blocking the entrance to the shell. Why? [To help keep the moisture and coolness in and help protect the soft, coiled body from hungry shore creatures.]

3. Role-playing Activities

A. How many different ways can you make a hermit crab?

B. Be a hermit crab in a tidepool. Use your long feelers and eyes on long stalks to tell you where you are going. Scurry about the tidepool, dragging your shellhouse along.

C. Be a hermit crab. You are growing and your shellhouse is too tight. You spy a beautiful empty snail shell, but another hermit has its eyes on the same snail shell. A fierce battle follows. Spread your legs wide and face the other hermit. With padded boxing gloves you charge. A hook to the right. A jab to the left. Your claws lock. Feel yourself roll over and over. Forget your prized snail shell and retreat, dragging your tattered and worn snail shell along.

D. Be a hermit crab stranded by the tide. Pull your soft curled body, the two long feelers, and the six pairs of walking legs deep into your mobile snail shell. Now use the two large claws for blocking the entrance to the shell.

E. Make a hermit crab with a partner. Be a hermit crab at high tide and at low tide.

4. Creative Writing Activities

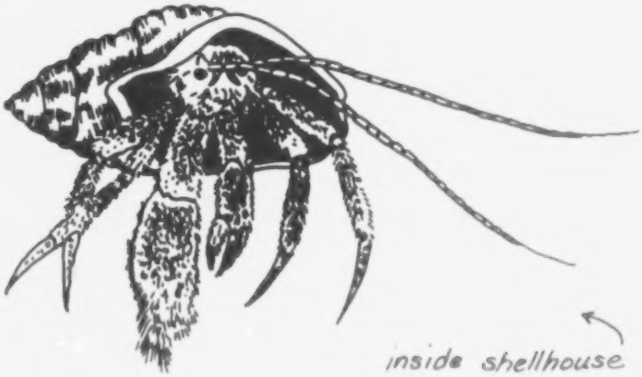
Write an imaginary story that describes the adventurous travels of a hermit crab looking for a new home. Illustrate your story.

5. Optional Field Trip Activities

Hermit crabs are especially fun to watch. Observe how a hermit crab uses its two long feelers. Watch how it moves its eyes. Notice the different sizes of hermit crabs. What kinds of snail shells do hermits prefer? Gather four or five hermits together in a jar of sea water. You may be surprised at what happens. Carefully remove one or two of the shells from the jar. What happens?

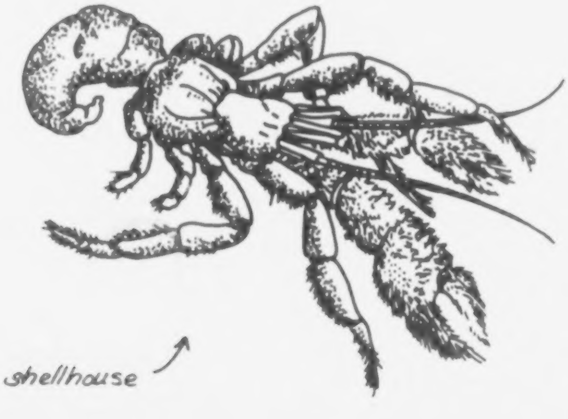
## HERMIT CRABS

When in tidal pools, the hermit crabs will probably attract attention first. Amusing creatures, they never lose interest in their lifelong search for a suitable home. Because their lower abdomen is soft and curled, as they grow they must constantly find larger shells to protect their bodies. The hermits, therefore, often fight vicious-looking battles over empty snail shells. If time permits, a hermit will grasp the new shell, turn it around, tap it with the antennae, and look inside. The inspection completed, the hermit quickly hops out of the old shell and slides tail first into the new one, and uses hook-like appendages for holding onto the shell house and the large claw for blocking the entrance to the shell.



inside shellhouse

HAIRY HERMIT CRABS



without shellhouse

# ACTIVITY 15:
# SEA ANEMONES
# (3 DAYS)

# ACTIVITY 15: SEA ANEMONES (3 DAYS)

**CONCEPTS:**

1. At high tide, or when in tidepools, sea anemones open and look like innocent sea flowers.
2. At low tide sea anemones draw in their tentacles and close up their sac-like bodies.

**OBJECTIVES:**

The children will be able to:

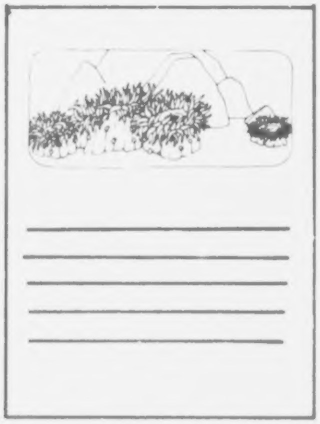
1. describe a sea anemone at high tide.
2. describe how a sea anemone traps food.
3. list at least three things a sea anemone eats.
4. explain how a sea anemone out of water keeps from drying out.
5. role-play a sea anemone at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

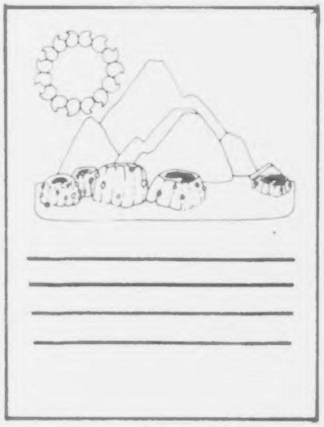
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Sea Anemones at High Tide" and "Sea Anemones at Low Tide"



High Tide



Low Tide

2. Possible questions for discussion:

Sea Anemones at High Tide

A. What do sea anemones look like? [Their bright colors and ring of tentacles make them look like flowers.]

B. Why are sea anemones called sea flowers? [They have beautifully beaded and brightly colored sac-like bodies and a ring of stinging tentacles around the mouth.]

C. Inference question: Do sea anemones really wear dresses? [No. Writers sometimes use such descriptions to make stories more interesting.]

D. Why are sea anemones not as harmless as they might first appear? [The ring of tentacles can sting small animals. The sting temporarily paralyzes the victim.]

E. What do sea anemones eat? [Snails. They also trap small shrimps, crabs, fish, etc.]

F. How do sea anemones eat? [The stinging tentacles curl inward and the sac-like body closes up. The anemone digests the snail and after a long while spits out the polished snail shell.]

G. Brain Buster Question: Are sea anemones harmful to humans? [No. A person can touch the tentacles and feel stickiness, but the tentacles do not cause pain.]

H. Brain Buster Question: Can a sea anemone move? [Yes. A sea anemone is capable of very slow, jerky movements.]

Sea Anemones at Low Tide

A. What do sea anemones look like that are left in deep tidal pools when the tide drops? [They still wear their beautiful flower-like dresses.]

B. What do sea anemones look like that are left stranded on the rocks by the dropping tide? [They close up and shrink to half their size. They look like jelly blobs on the sides of rocks.]

C. How do sea anemones keep from drying out? [Before the tide uncovers them, sea anemones draw in their tentacles and close up their sac-like bodies, with their stomachs full of seawater.]

D. Brain Buster Question: Do any sea anemones feed at low tide? [A sea anemone in a tidal pool continues to use its tentacles to trap other tidepool animals, but a sea anemone out of water closes up.]

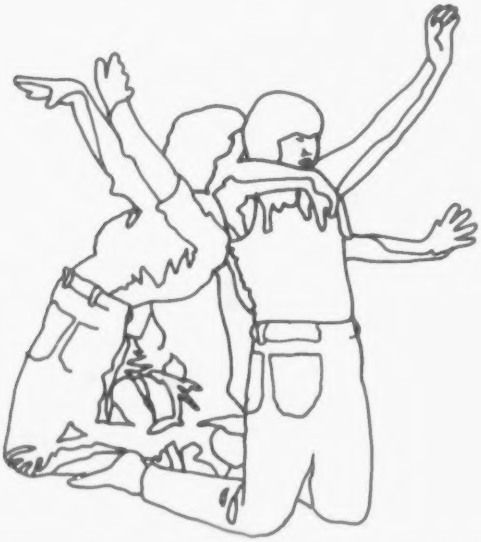
3. Role-playing Activities

A. How many different ways can you make a sea anemone? Show me one way. Show me another way.

B. You are a sea anemone at high tide. Suddenly a small, shrimp-like animal darts across your body. What will you do?

C. Be a sea anemone stranded on a rock at low tide. Fill your stomach with seawater before the tide drops. Now draw in your long, beautiful tentacles and close your sac-like body, like a purse string pulled tightly.

D. Make a sea anemone with a partner. Be a sea anemone at high tide and at low tide. Work in groups of 2, 3, 4 or 5.



Become a sea anemone feeding at high tide.

4. Creative Writing Activity

Pretend you are a beautiful "sea flower" at high tide. Your long, graceful tentacles sway to and fro with the current. What happens next?

5. Art Activities

A. Draw a picture of a sea anemone opened at high tide.

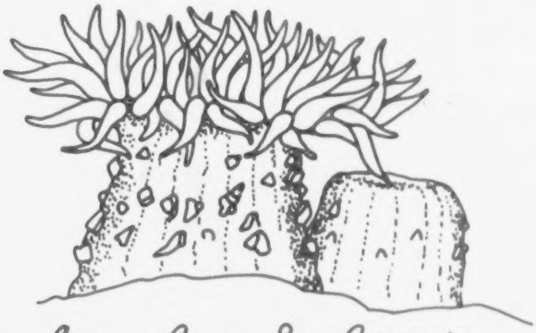
B. Draw several pictures showing how a sea anemone closes up tightly.

6. Optional Field Trip Activities

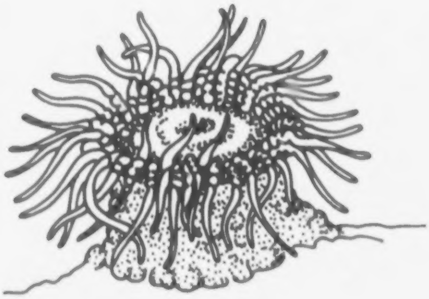
Draw a picture of an opened sea anemone underwater. Draw a picture of a closed sea anemone. Drop small pebbles or snail shells into sea anemones. Observe what happens. How long does it take the anemone to spit out the shells? Drop a dull penny into a sea anemone. What happens?

## SEA ANEMONES

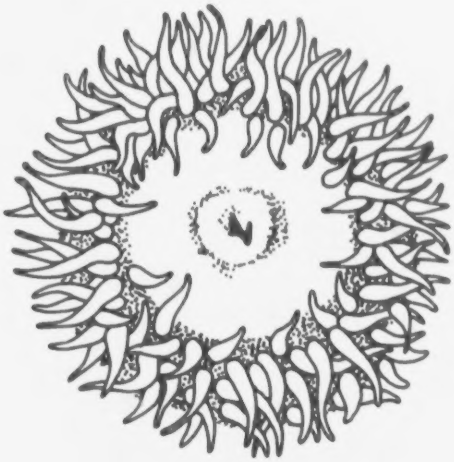
Several species of beautifully colored sea anemones live in the larger tidal pools and in sheltered rock crevices, especially on the open coast. They usually remain in one place, but are capable of very slow movement. The tiny stinging capsules at the tip of the tentacles trap and paralyze animals such as small fish, crabs, shrimps, snails, etc. The stinging tentacles are usually harmless to humans. The tentacles surround the mouth, which is a slit-like opening leading to a gullet or stomach. The anemone swallows the victim whole and digests it, then spits out the indigestible bits and pieces of shell, and expands back into its innocent-looking, flower-like posture.

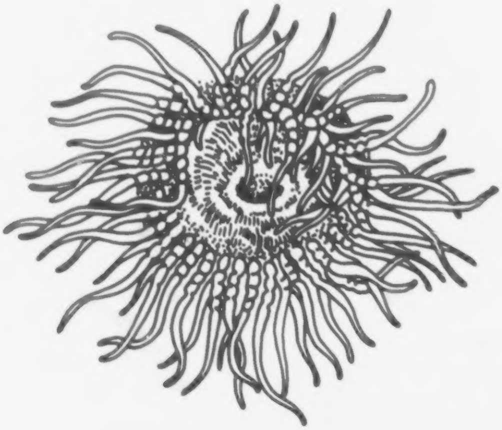


GIANT GREEN SEA ANEMONE



GREEN BURROWING ANEMONE





# ACTIVITY 16:
# SEA URCHINS
# (2 DAYS)

## ACTIVITY 16: SEA URCHINS (2 DAYS)

**CONCEPTS:**

1. At high tide, or when in tidal pools, sea urchins move about, grazing on the seaweed forests.
2. At low tide, or when stranded on rocks, sea urchins stop moving and stop scraping at the seaweed forest.

**OBJECTIVES:**

The children will be able to:

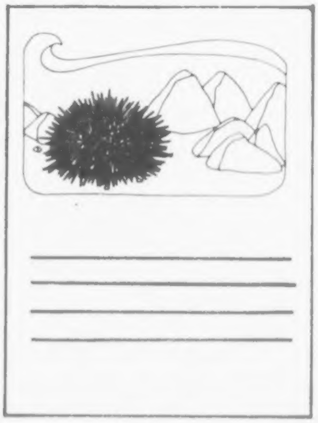
1. describe a sea urchin at high tide and at low tide.
2. describe how sea urchins move.
3. describe how sea urchins eat.
4. explain how a sea urchin out of water keeps from drying out.
5. role-play sea urchins at high tide and at low tide.

**TEACHER PREPARATION:** Read Teacher Information.

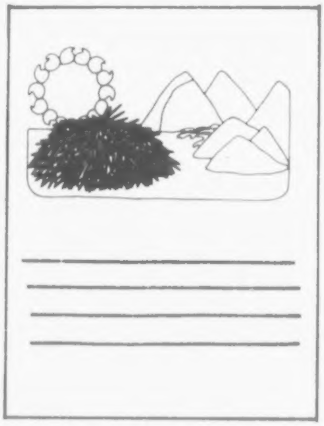
**MATERIALS:** Class set of "High Tide, Low Tide."

**PROCEDURES:**

1. Read "Sea Urchins at High Tide" and "Sea Urchins at Low Tide."



High Tide



Low Tide

2. Possible questions for discussion:

   Sea Urchins at High Tide

   A. What colors are sea urchins? [Some are green, some red, and some purple.]

   B. Why are sea urchins sometimes called "sea porcupines?" [Because the long sharp spines look like porcupine quills.]

C. How do sea urchins move? [The tube feet cling to rocks with little suction cups and help to pull the sea urchin along, while the long sharp spines all push in the same direction.]

D. How do sea urchins protect themselves from being eaten? [Should a hungry sea star or rock fish pass by, the long sharp spines all point, like spears, in the direction of the would be enemy.]

E. What do sea urchins eat? [Mostly seaweeds]

F. How do sea urchins eat? [They have five movable teeth on the underside that come together to make a powerful scraper. They scrape at the seaweed forests until whole forests are cut away at the roots.]

G. Brain Buster Question: Why are sea urchins three different colors? [Each species, or kind, is a different color.]

Sea Urchins at Low Tide

A. Where do sea urchins go at low tide? [Some are low enough on the shore that they are able to retreat with the dropping tide. Some become stranded in rock crevices or on rocks lit by the bright sunlight.]

B. Do sea urchins move at low tide? [Sea urchins stranded in tidepools continue to move, but a sea urchin out of water stops, because it needs the surrounding sea water to give it support and to enable the tube feet to work.]

C. Brain Buster Question: How does a sea urchin out of water protect itself? [Before the tide drops, it attaches some of its tube feet to rocks and digs its long sharp spines into cracks and crevices. It keeps a strong foothold and stays cool and moist inside its bristling water-filled shellhouse.]

3. Role-playing Activities

A. How many different ways can you make a sea urchin? Show me one way. Show me another way.

B. Be a sea urchin at high tide. Cling to the rocks with your long tube feet. Move along using your tube feet to push and pull, while the long, sharp spines all push in the same direction. As you move slowly along, scrape at the seaweed forest with your five moveable teeth.

C. Be a sea urchin stranded on the rocks at low tide. Fill your stomach with seawater before the tide goes out. To keep a strong foothold, attach your tube feet to rocks and dig those long, sharp spines into cracks and crevices. Your long, sharp spines hang down like limp porcupine quills. Withdraw the tube feet on the top of your bristling water-filled shellhouse.

D. Work in groups of 2 to 5. How many different ways can you make a sea urchin? Make the sea urchin move.

E. Work in groups of 2 to 5. You are a bristling sea urchin with long, sharp spines. It is high tide. Suddenly a hungry rock fish swims by. Quick! Point all the long sharp spines, like spears, in the direction of the rock fish.

4. Art Activities

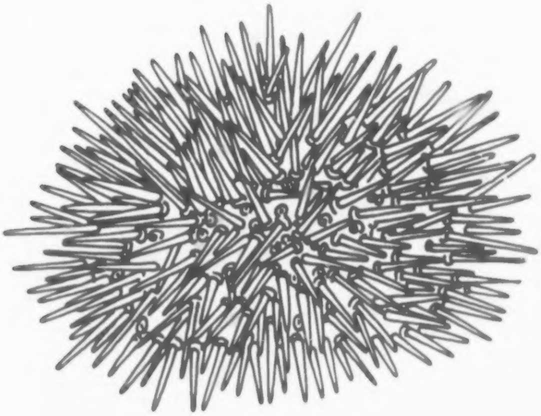
A. Draw a picture of a sea urchin at high tide. Show how the tube feet and the long, sharp spines push and pull the sea urchin along.

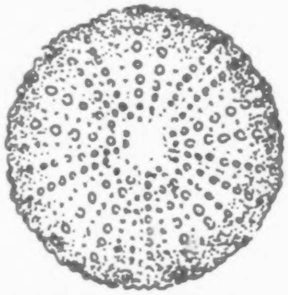
B. Draw a picture of a sea urchin at low tide. What happens to the tube feet and the long sharp spines?

# SEA URCHINS

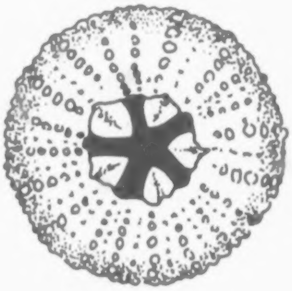
Huge herds of sea urchins graze in the larger tidepools or on the bottom off shore; some red, some purple and some green, depending on the species. These sea "porcupines" have long tube feet, and bristling spines on ball and socket joints which give a surprising range of movements. Sea urchins have five moveable jaws, or teeth, called "Aristotle's Lantern" because the Greek philosopher and naturalist described the structure as being similar to an ancient lamp. These teeth come together as a powerful feeding mechanism. Sea urchins feed mostly on seaweeds, especially kelp, and sometimes destroy whole kelp forests by cutting away at the lower portions of the plant. Look for the brittle white "shell," or test, of sea urchins, and examine the five point star patterns, a clue to the close relationship of sea urchins to sea stars.

SEA URCHIN





"test" top view



bottom view with "Aristotle's Lantern"

# ACTIVITY 17:

# FIELD TRIP TO A ROCKY SHORE

## (1 DAY)

## ACTIVITY 17: FIELD TRIP TO A ROCKY SHORE (1 DAY)

**CONCEPTS:**

1. The rocky shore is the home of a great number and a wide variety of seashore plants and animals.
2. It is possible to learn a great deal about seashore plants and animals through our own observations: seeing, touching, feeling, smelling, tasting.
3. It is possible to ask questions and answer questions by doing simple investigations.
4. Seashore plants and animals need to be protected.

**OBJECTIVES:**

The student will be able to:

1. identify at least 12 common rocky shore animals without the aid of a book.
2. observe rocky shore animals at high tide and at low tide.
3. formulate questions based on first hand observations.
4. invent simple experiments to help answer questions.
5. conduct simple experiments at the seashore.
6. treat seashore animals with care.

**TEACHER PREPARATION:**

1. Read Teacher Information, "Taking Care."
2. Check the tides. Get a tide book from any marina or large book store. Lowest tides occur in April, May, June, July, August and early September. A tide of less than three feet is very good and will reveal a great deal of life.

**MATERIALS:**

Equipment for a one day trip:
For each student:

1. old pair of jeans
2. rain gear (including hood)
3. rubber boots and woolen socks
4. long sleeved cotton shirt
5. (optional) food for a cookout

For the class (optional):

1. 1 shovel
2. magnifying glasses
3. thermometers
4. identification books
5. small nets
6. 2 or 3 gallon jars
7. clear plastic freezer bags
8. cameras
9. binoculars
10. field notebooks - a spiral steno pad with a pencil attached by a string is particularly handy
11. string
12. matches
13. plastic buckets - the buckets should contain no trace of detergents, bleach, or poisons. One contaminated bucket can destroy a host of organisms.

**PROCEDURES:**

1. Before beginning structured activities at the seashore, it is a good idea to allow the students a period of unstructured time in which to manipulate and explore nature and to ask questions, probe, and investigate without guided instruction. This is especially true of students from urban or rural areas who have seldom, if ever, experienced the thrill of the seashore. This first experience is a period of intense excitement and the students will naturally want to explore on their own. Any attempt to structure the situation may result in the mutual frustration of all. Obviously, you will want to set boundaries and caution the students about conservation and safety, but for the first hour or so you should allow the students to explore at their own pace. Let their natural curiosities lead them into the infinite exploratory possibilities of the seashore.

2. Tidepool Sitting: After the students have had a chance to explore on their own, you will need to get them to slow down and learn to investigate in a more systematic way. Have the students locate tidepools. Ask them to sit very quietly, do not move or talk for 10 to 15 minutes. Look, listen, smell, think, enjoy. (At first it is a good idea to simply let the students observe, without writing. On later trips you might want to ask the students to record their observations or write a list of 5 questions that they have about tidepools.)

Things for students to think about:

A. How many plants and animals can you identify without the aid of a book?
B. Watch carefully how different animals eat. How are they alike? How are they different?
C. Watch carefully how different animals move. How are they alike? How are they different?
D. Are there any animals that seem to be closely related? Which ones?
E. Think about examples of camouflage. Do various animals blend perfectly with their surroundings? If so, how?
F. Which animals appear to be attached to something else? How do these animals attach themselves? Which animals move freely about? Where do they go?

3. Discussion: Bring students (preferably 7 to 10 students at a time) back together again. Discuss their observations. What questions do they have? Try to get the students to offer inferences that might answer their own questions. Can any students invent simple experiments that might help answer their questions?

4. Inquiry Activities with Seashore Plants and Animals: Refer to the "Optional Fieldtrip Activities" listed at the end of each activity in this guide. Complete as many activities as possible and caution the students to handle the animals with care.

## TAKING CARE

### Protect Seashore Plants and Animals

While on the seashore, investigate the plants and animals and their habitats; investigate them and enjoy them, but do not destroy them.

Turn the rocks back over
When turning over a rock, do so gently. Try not to crush too many animals living on, beside, or under the rock. Put the rock back the way it was, or lean it face down against another rock.

Fill in any holes
When digging for burrowing animals, do not leave piles of sand or mud on the beach; many burrowing animals float away or die when the tide returns. Furthermore, the unnatural holes, and piles of mud or sand many kill many small clams or other animals whose burrows can no longer reach the surface.

Cover abandoned animals with seaweed
When investigating animals living on or under seaweeds, return the animals and cover them again with moist protective weed, otherwise the sun may dry them out.

Avoid walking on animals
When walking on rocky shore try to walk on bare rocks or on the patches of sand and mud between rocks. Try not to crush barnacles and other organisms living on the surface. Do not run.

Leave the specimens in their natural habitat
Do all of your investigating at the seashore. Do not move animals from one tidal zone or one type of beach to another. Do not take any organisms away.

Do not mount, dry or preserve specimens
Many people boil snails to make jewelry from the beautiful shells, or dry sea stars and sea urchins to decorate basements and bulletin boards. For such purposes use only the discarded shells of animals already dead.

Camp and leave no trace
Put out any fire you might build and scatter the pieces. Pack out all of your garbage. In every way, try to leave the beach and its inhabitants as they were.

Rules for Safety:

Check the tides
Learn to read a tide table. Before going to the beach know how long the tide will fall and at what time the tide will start to rise.

Keep your eye on the ocean
Continually check your times and locations. People often become so involved with looking at tidepools that the rising tide cuts them off from the land and they become stranded. Do not keep your back to the sea.

Do not climb shoreline rock faces
Do not climb cliffs facing the ocean; the tide will rise and might trap you. In addition, shoreline cliffs are frequently of soft sandstone or clay, and might crumble beneath your weight.

Never walk on floating logs
Do not walk on log booms or on stranded logs in shallow water. Loose, floating logs roll unpredictably. Avoid walking on logs resting on beaches in bays and along estuaries; an incoming tide can turn them over or sweep them away.

Never fool around
Don't play practical jokes. Do not run or push or shove. Such fun might end in tragedy.

Explore in groups
Never explore alone. Always explore with a partner and preferably in threes - if one is hurt the second can stay while the third goes for help.

# EVALUATION VOCABULARY

NAME ____________________

# EVALUATION - PART A

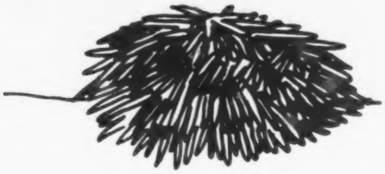
**Directions**

Write the name of the animal below the drawing.
Use the list of animals to help you remember.

Animals:

SEA ANEMONE
LIMPET
BLUE MUSSEL
SEAGULL
SEA URCHIN
BLENNY
PURPLE SHORE CRAB
BARNACLE
PERIWINKLE
PURPLE OR ORANGE SEA STAR
TIDE POOL SCULPIN
HERMIT CRAB

## HIGH TIDE ANIMALS



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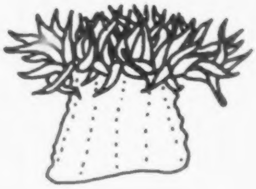

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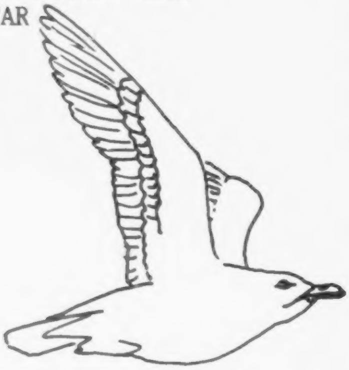

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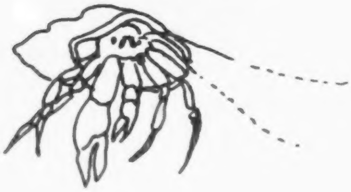

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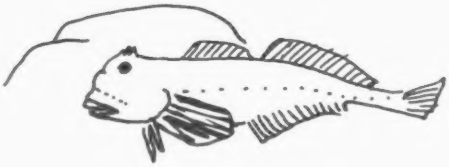

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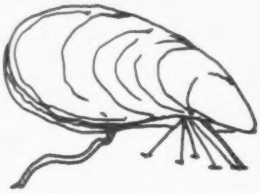

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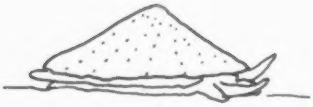

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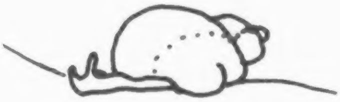

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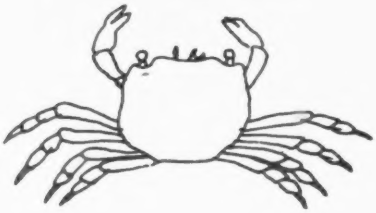

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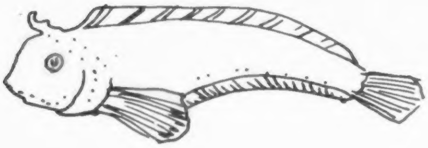

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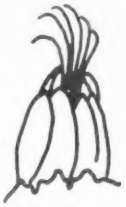

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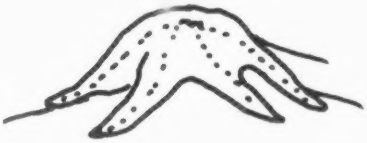

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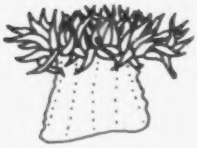
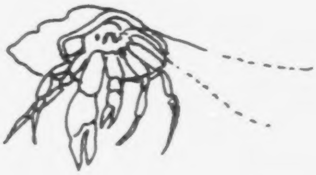
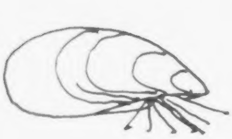
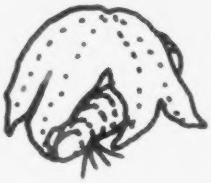
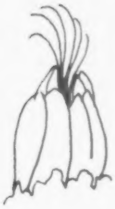
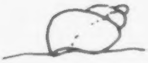
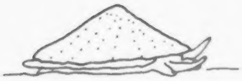
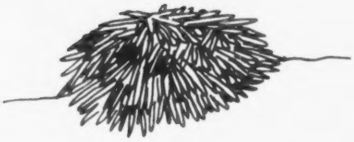
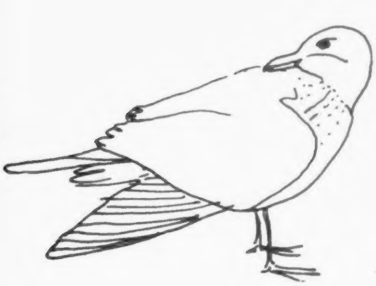
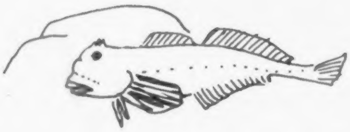
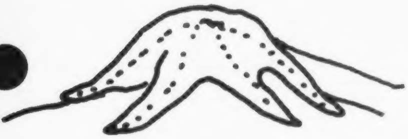
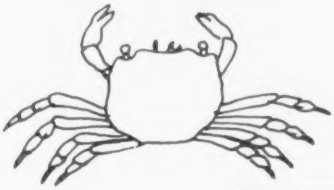
NAME ____________________

## EVALUATION - PART B

**Directions**

Look at the sketch of the animal. If this is how the animal looks at high tide, place an "X" in the "High Tide" column. If the sketch is of the animal at low tide, put an "X" in the "Low Tide" column.

| | HIGH TIDE | LOW TIDE | | HIGH TIDE | LOW TIDE |
|---|---|---|---|---|---|
|  | ________ | ________ |  | ________ | ________ |
|  | ________ | ________ |  | ________ | ________ |
|  | ________ | ________ |  | ________ | ________ |
|  | ________ | ________ |  | ________ | ________ |
|  | ________ | ________ |  | ________ | ________ |
|  | ________ | ________ |  | ________ | ________ |

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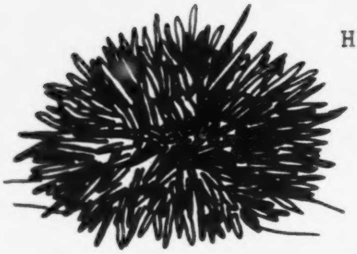

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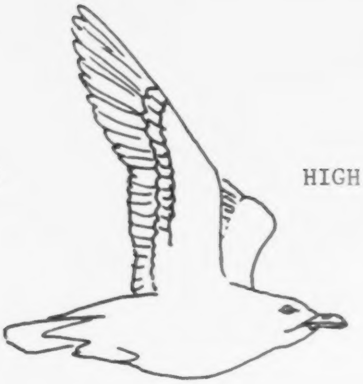

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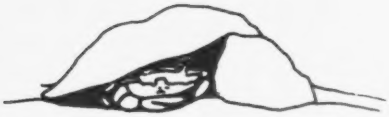

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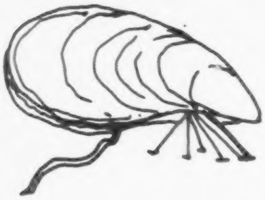

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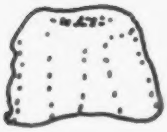

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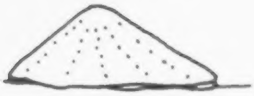

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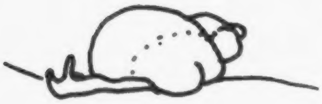

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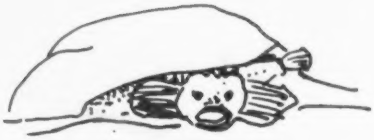

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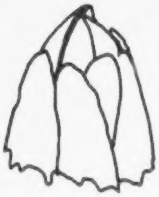

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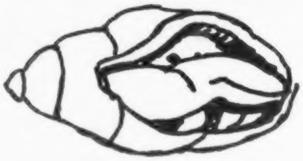

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NAME ____________________

## EVALUATION - PART C

Draw a picture of a barnacle at high tide.

Draw a picture of a barnacle out of seawater at low tide.

Draw a picture of a limpet feeding at high tide.

Draw a picture of a limpet out of seawater at low tide.

Draw a picture of a sea anemone at high tide.

Draw a picture of a sea anemone out of seawater at low tide.

Draw a picture of a sea urchin moving at high tide.

Draw a picture of a sea urchin out of seawater at low tide.

## TEACHER'S GLOSSARY OF TERMS

Algae: One of the more primitive plant forms able to use the sun's energy for making food; ocean seaweed.

Antenna: A "feeler" or pair of "feelers" on the heads of insects, shrimps, and crabs.

Barnacle: Any of several species of small sea animals with a thin cone-shaped shell. The larvae cement themselves permanently to rocks, wharves, and the bottoms of ships.

Bivalve: A shellfish having two shells hinged together by a muscle. Examples: oyster, clams, scallops, and mussels.

Byssus threads: Strong threads produced by a gland, attaching mussels, and some clams and oysters, to rocks and other hard surfaces.

Camouflage: A color pattern enabling some animals to hide in, or blend in with their surroundings.

Carapace: The hard shell covering the body and backs of crabs and shrimps.

Crab: A crustacean having a flattened body, four pairs of legs, a pair of grasping claws, and a small abdomen.

Diatom: Any one-celled microscopic plant living in water, some forming a major component of plankton and others contributing to the thin brown scum that falls to the bottom.

Foot: The wide flat-ended or wedge-shaped muscle used for crawling or digging such as in snails, limpets, chitons, abalones, and clams.

Holdfast: A structure anchoring seaweeds to rocks and other hard surfaces.

Intertidal: The area between the high tide mark and the low tide mark on a seashore.

Limpet: A slow moving animal having a large, flat muscular foot and a hard shell into which the animal can partially withdraw.

Mussel: A bivalve clinging to rocks and pilings with byssus threads.

Operculum: A trapdoor, used for closing the shell of a snail or the tube of a worm; a protective device for an animal that has withdrawn into its shell or tube.

Organism: A single living plant or animal.

Paralyze: To inject a toxin in order to make a prey inactive.

Plankton: The minute plants and animals drifting or swimming in the ocean; the food of filter-feeders.

Predator: An animal that eats other animals.

Prey: An animal eaten by another animal.

Scavengers: An animal that eats the remains and wastes of other animals and plants.

Sea Anemone: An attached marine animal with a body cavity broken up into a number of chambers, tentacles with stinging cells around the mouth opening, and having a flower-like appearance.

Sea Star: A star-shaped animal having a central body with five or more rays, and tube feet which adhere firmly to rocks and aid in movement.

Sea Urchin: Animals with long, bristling spines, tube feet, and five moveable jaws; related to sea stars, and sand dollars.

Seaweed: A marine algae.

Snail: A small, slow-moving animal with eyes sometimes on stalks, a muscular foot, and a hard coiled shell into which the snail can at least partially withdraw.

Tentacle: A long, arm-like appendage, generally used for feeding.

Tidal pool: A small pool of seawater left on a rocky shore when the tide goes out.

Tube feet: Special attachment organs for movement and for collecting food such as in sea stars, cucumbers, and urchins.

Univalve: A shellfish with only one shell. Examples: snails and limpets.

NAME ____________________

## STUDENT'S VOCABULARY

Barnacle

Blenny

Crab

Crevice

Diatom

Foot

Feelers

Hermit Crab

High Tide

Limpet

Low Tide

Mud Flat

Mussel

Plankton

Periwinkle

Rocky Shore

Sandy Beach

Sea Anemone

Seagull

Seashore

Sea Star

Sea Urchin

Seaweed

Shore Crab

Snail

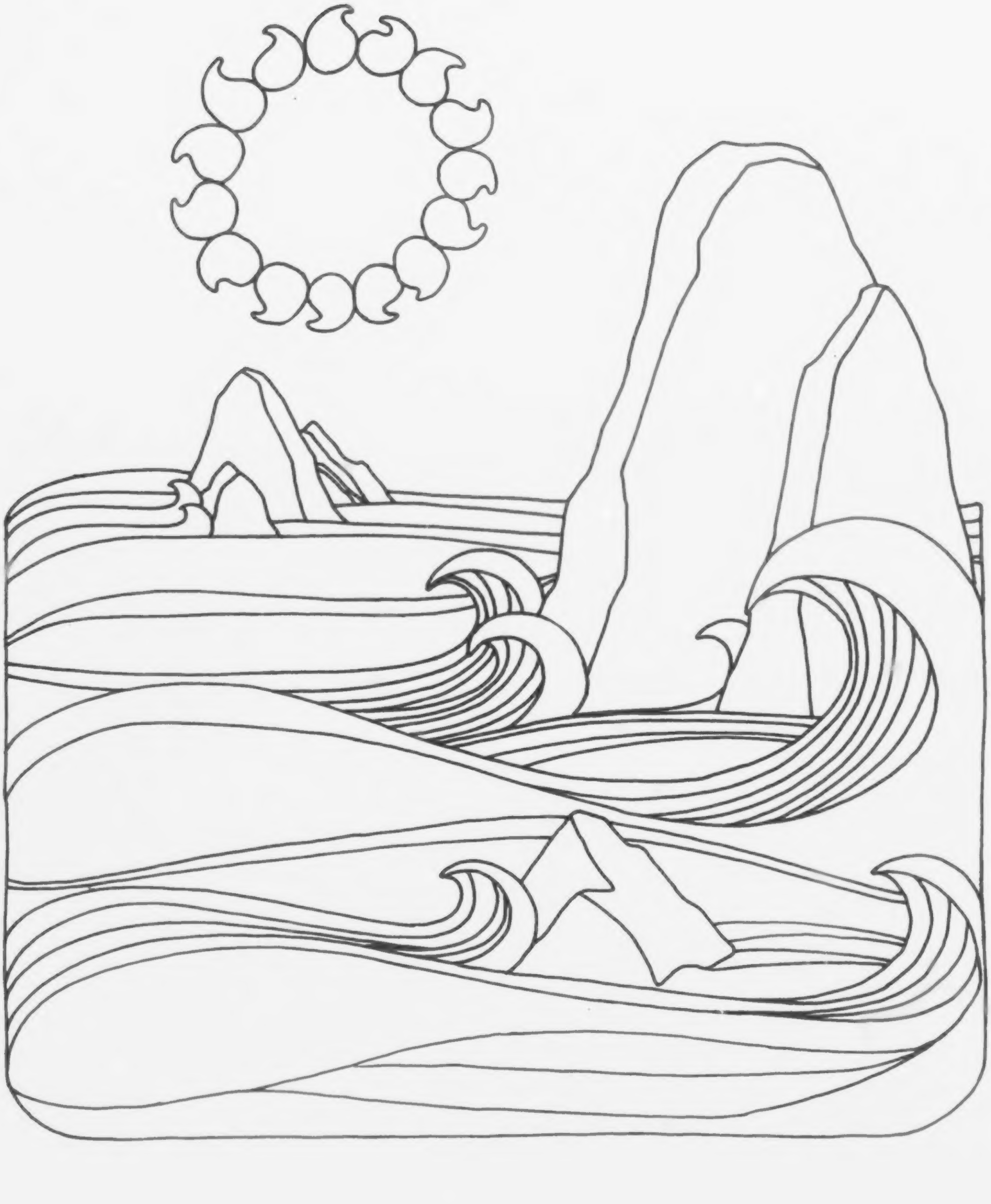
Tide

Tidal pool

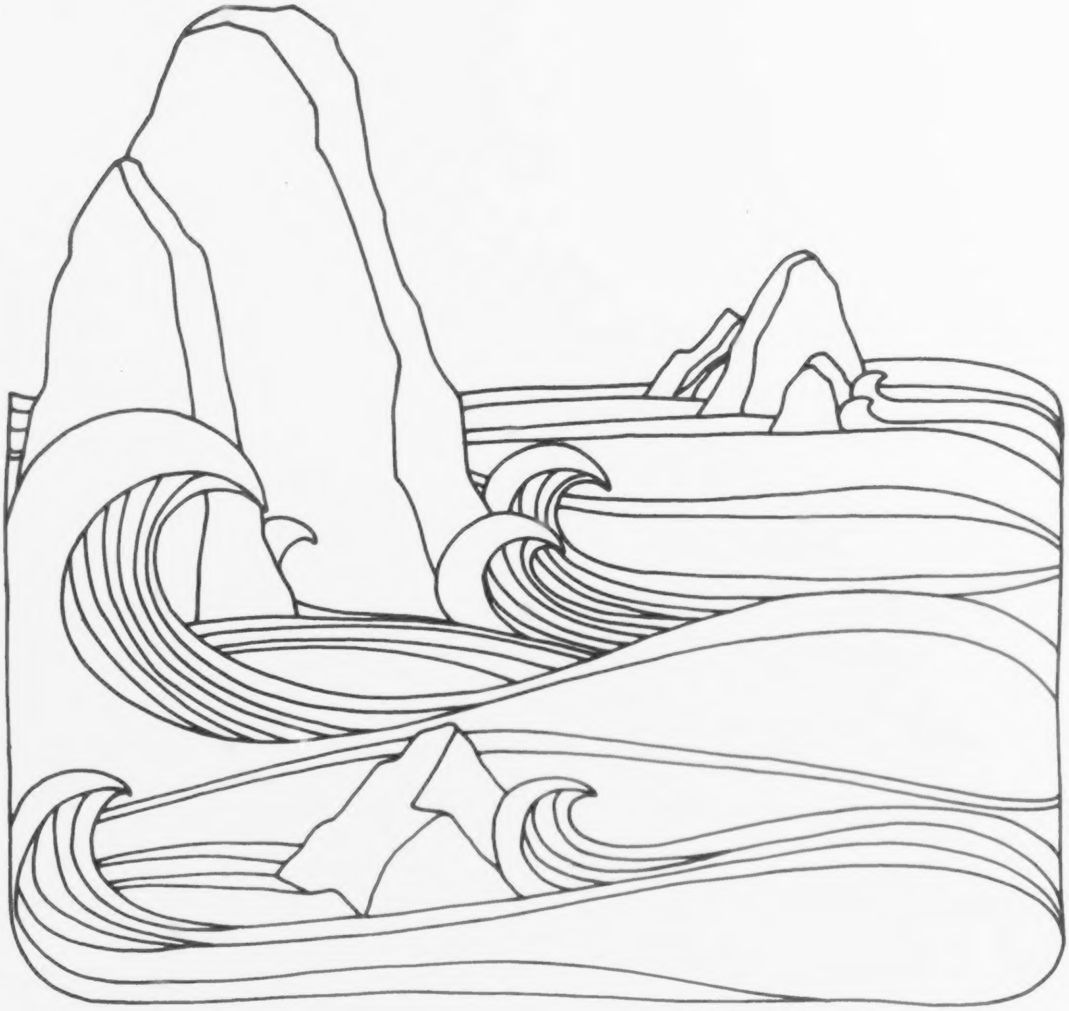
Tentacle

Tidepool Sculpin

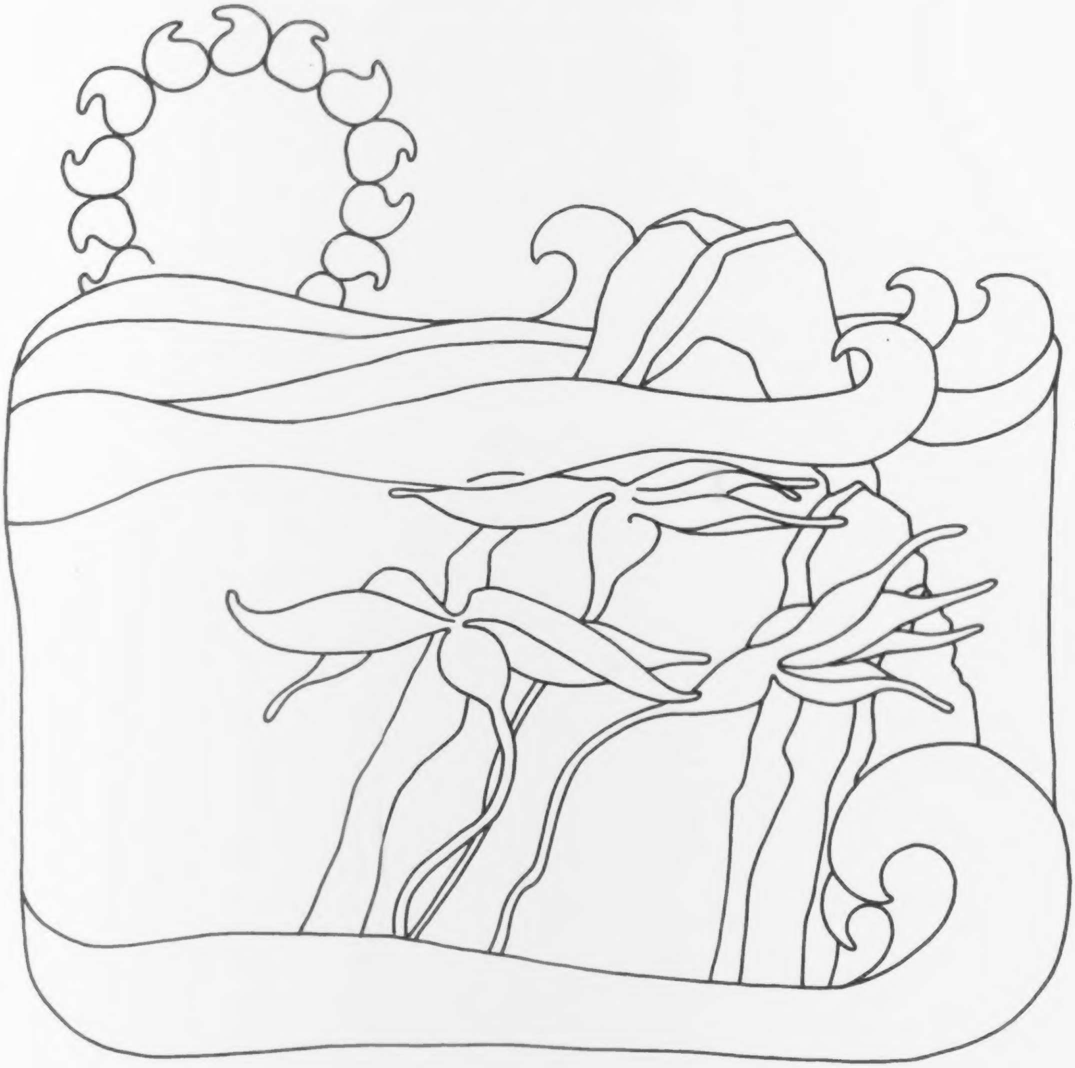
Tube Feet



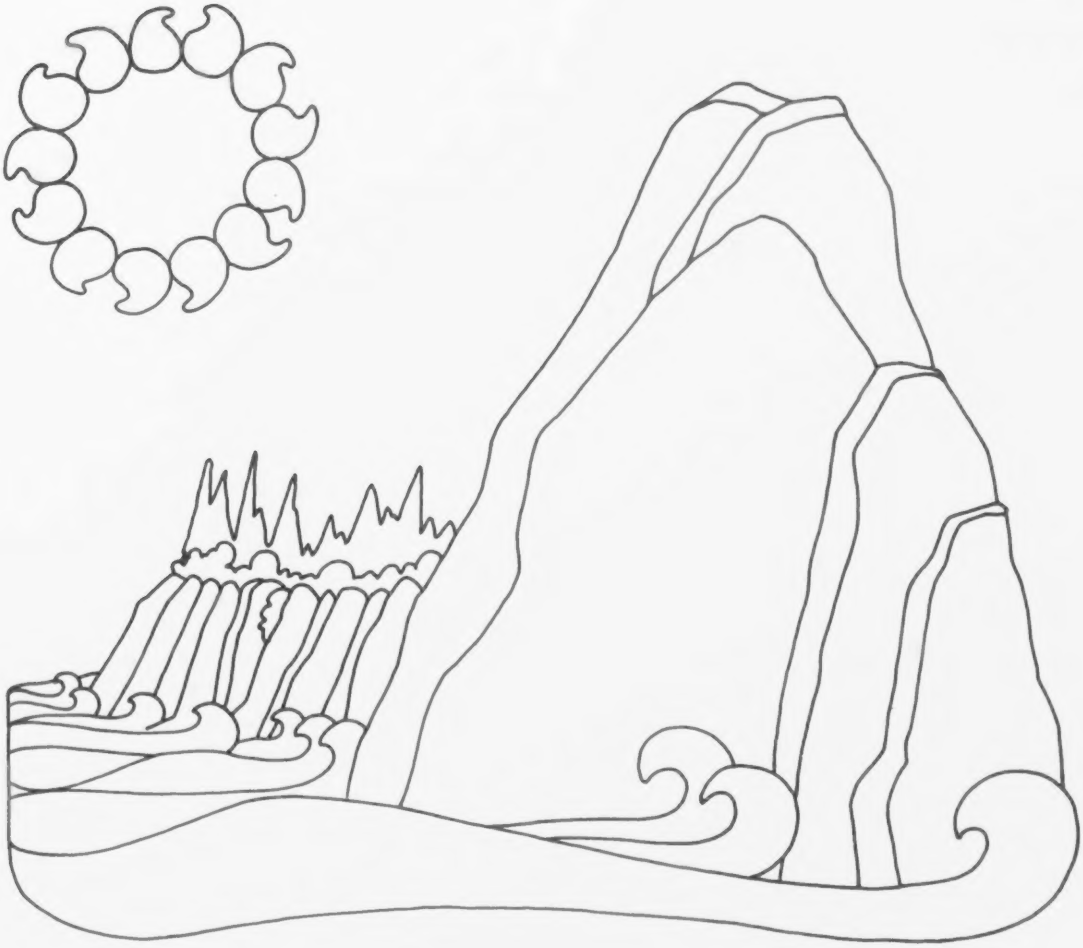
# HIGH TIDE, LOW TIDE



The rocky shore is a battleground between the land and the sea. Everywhere are signs of the battle: sea caves carved by the waves; giant boulders torn from the land; rocks tossed onto the shore and smoothed by the sea. Huge winter storms and high tides sometimes smash against the rocks. Day by day, year by year, waves smash against the cliffs. As the years pass, the cliffs fall into the sea and the sea pushes into the land.

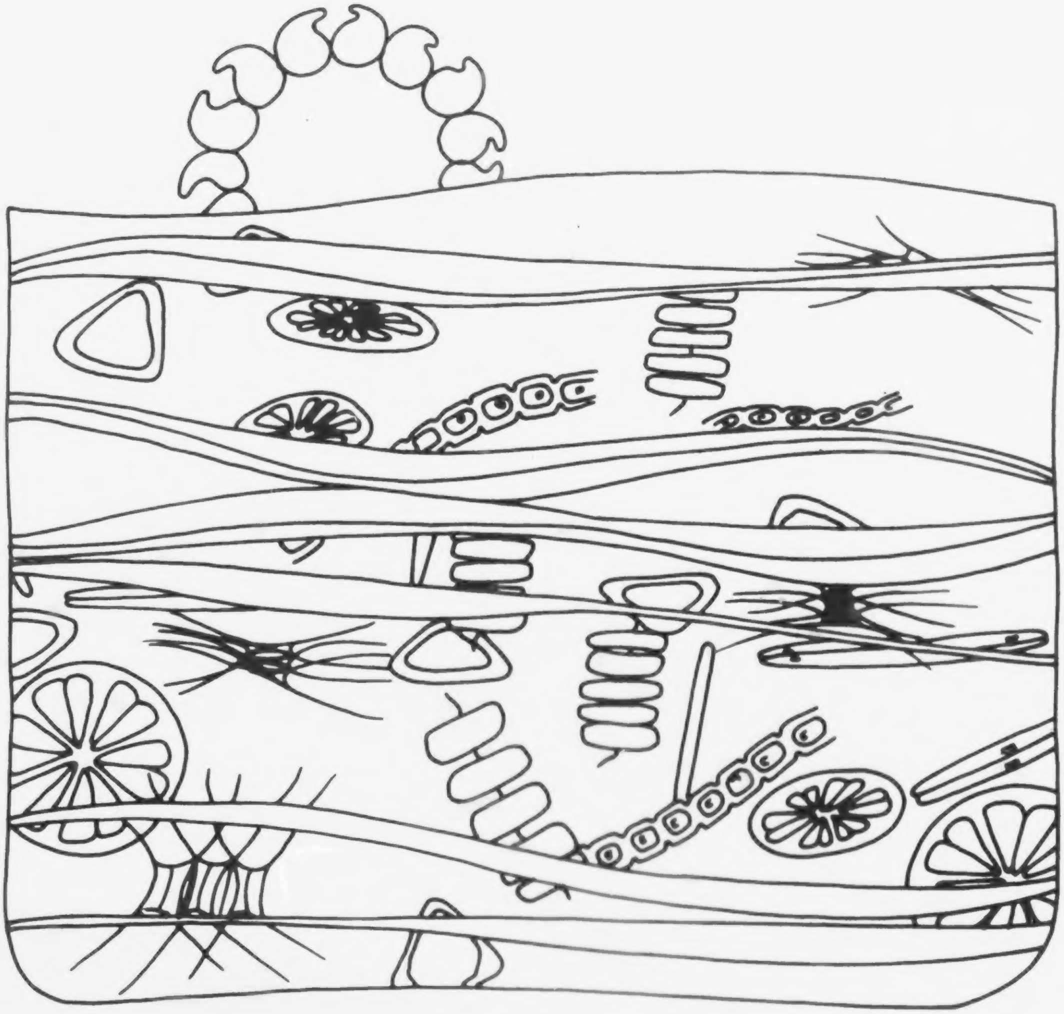


Twice each day the ocean waters rise along our coastline. Twice each day the ocean waters fall. This rising and falling of ocean waters is called the tides. At high tide the seashore is covered with ocean water. Rolling white waves crash upon rock, sand, and mud. Bubble, gurgle, splash!

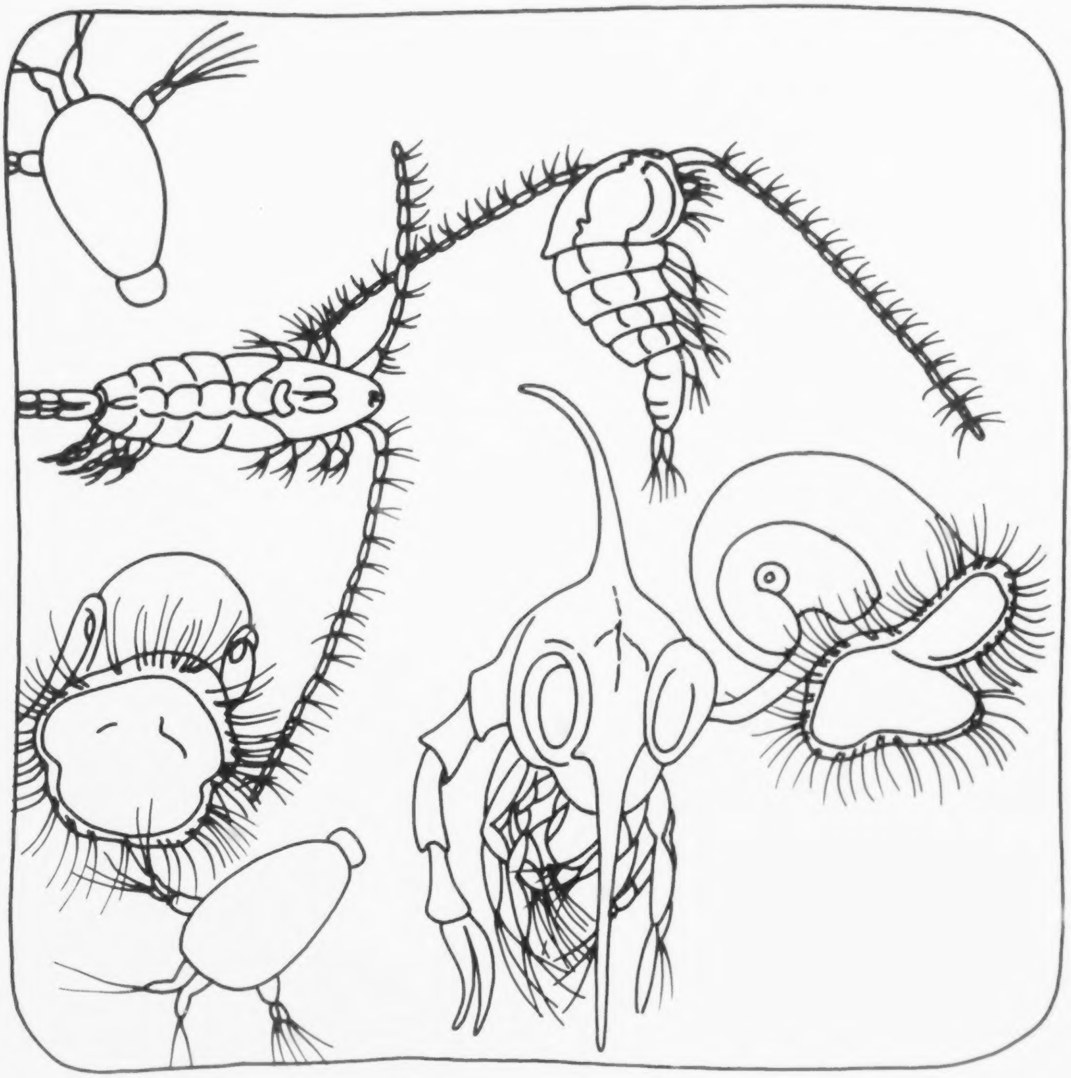


When the tide turns from high tide to low tide, the ocean water slowly flows out to sea. At low tide, gentle waves lap against the shore. The rocks that earlier were covered with high water glisten wet in the bright sunlight.

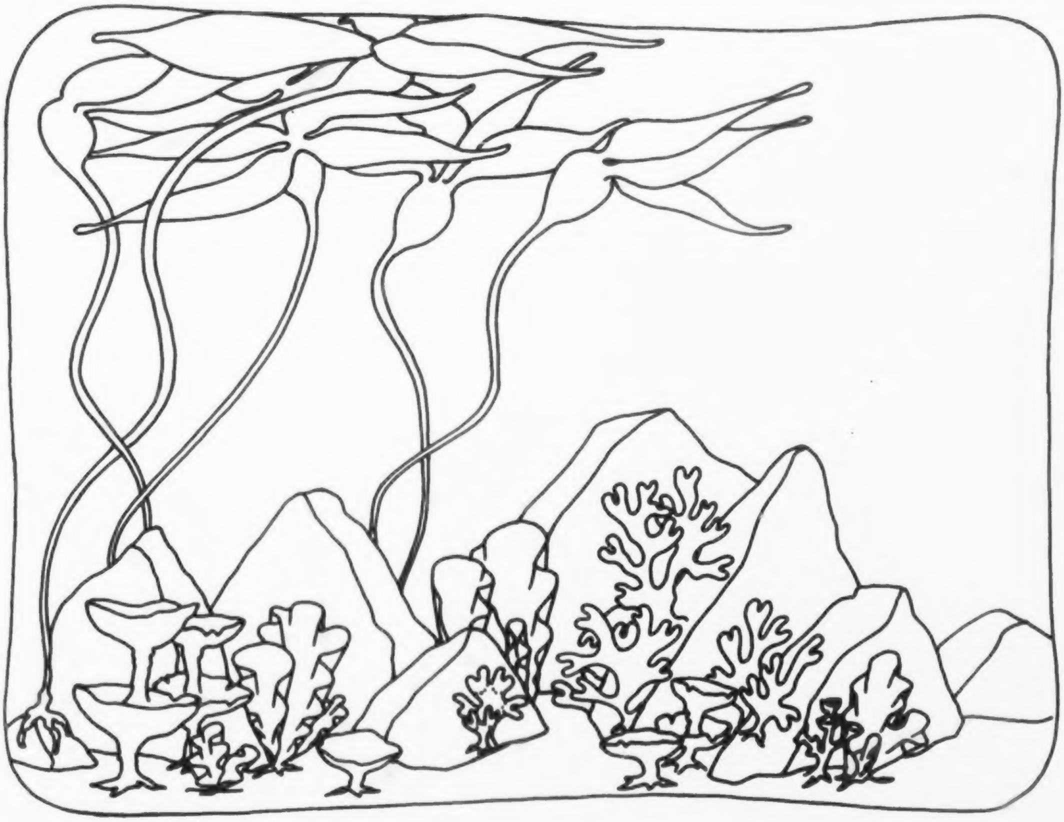
The dropping tide leaves glassy blue pools of water in holes and cracks. Seaweeds of many colors line the walls. Whole cities of animals live in each tidepool. These tidepools provide shelter for plants and animals that cannot live in the drying sunlight.



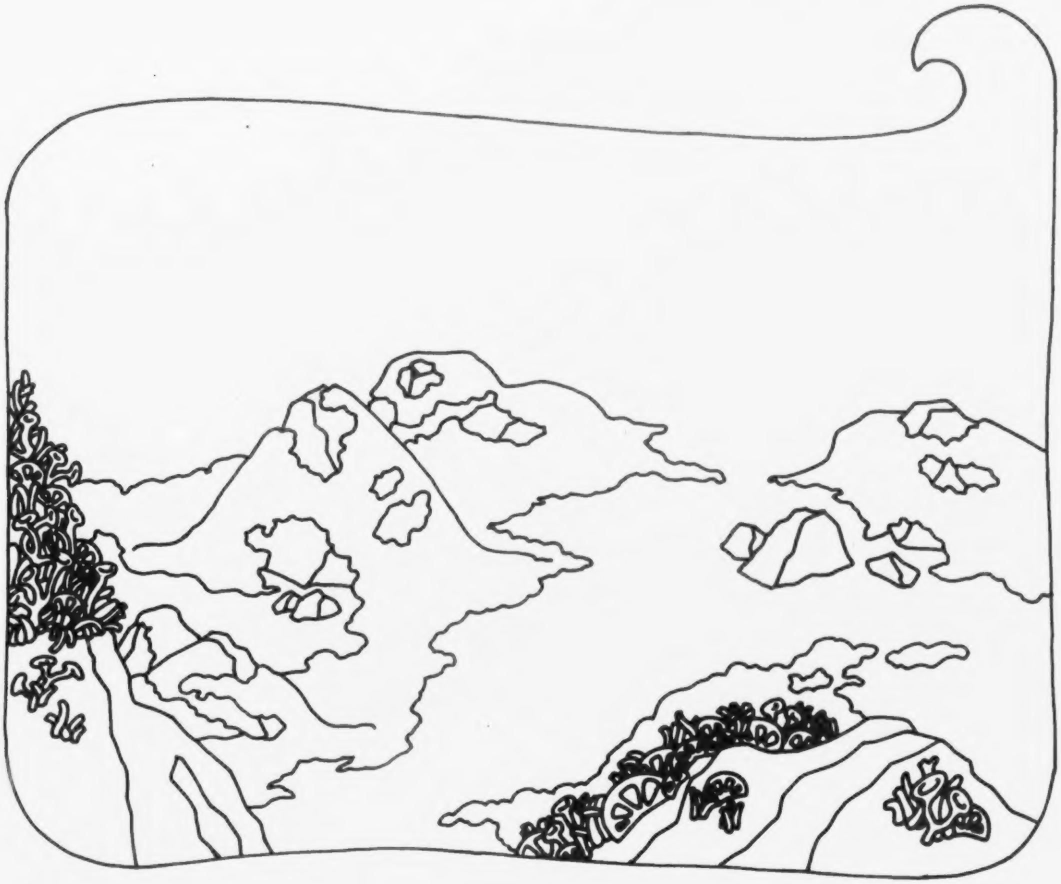
The top of the sea sparkles in the sun. The bright sun shines down into the water. Then the light fades away into darkness. Where the sea is light, tiny plants called diatoms, live crowded together. Each diatom is so small that you can see it only with a microscope. Hundreds of diatoms can fit into a drop of sea water. Some diatoms look like glass boxes. Some diatoms look like twinkling stars. Some diatoms look like sparkling jeweled necklaces.



The sea is crowded with tiny, tiny animals, tons and tons of tiny animals. Each is the size of a pinhead. The insect-sized, dragon-like animals have long swishing feelers, long sharp horns, and feathery tails: copepods, amphipods, and isopods. Swarms of plants and animals make up the thick soup we call plankton. This mixed crowd of tiny plants and tiny animals always drifts near the surface of the sea.

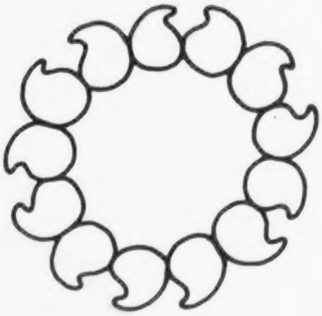


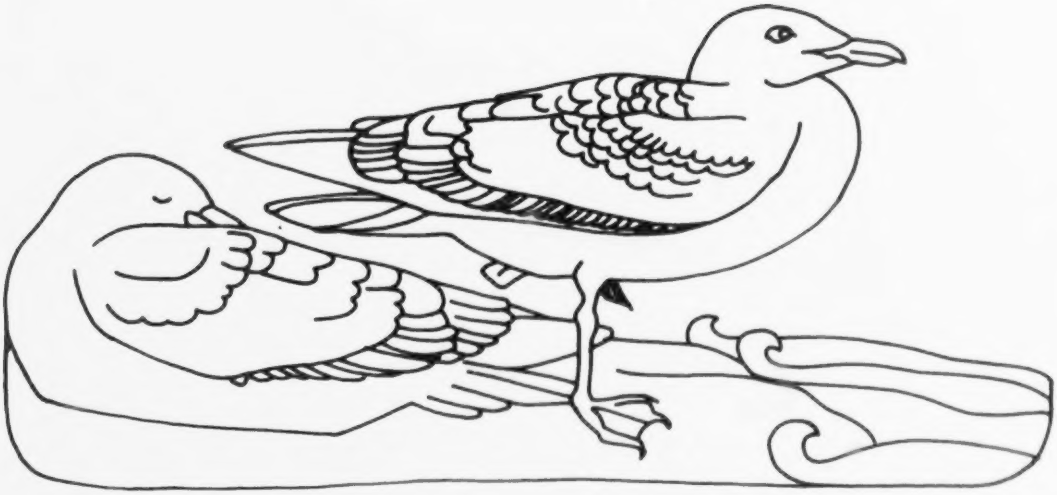
Some plants that live in the ocean are very large. They are called seaweeds. There are many seaweed forests in the ocean. Some seaweeds come into view at low tide like bright green sea lettuce that is good to eat and slippery brown rockweeds with air bladders that pop underfoot. Beautiful pink, red, or purple coral seaweeds cover the rocks, looking like thin splotches of red paint. Some seaweeds grow as tall as trees. Giant brown and olive-green kelp floats on the ocean surface, swaying to and fro, to and fro. The seaweed forests sway to and fro with the rise and fall of the tide.



Some plants are very, very tiny. They are so tiny that millions and millions of tiny plants cover every centimeter of every rock, like a carpet of thin tissue paper. On some rocks the carpet is green. On other rocks the carpet is brown. The carpet of tiny green plants feels slimy to touch.

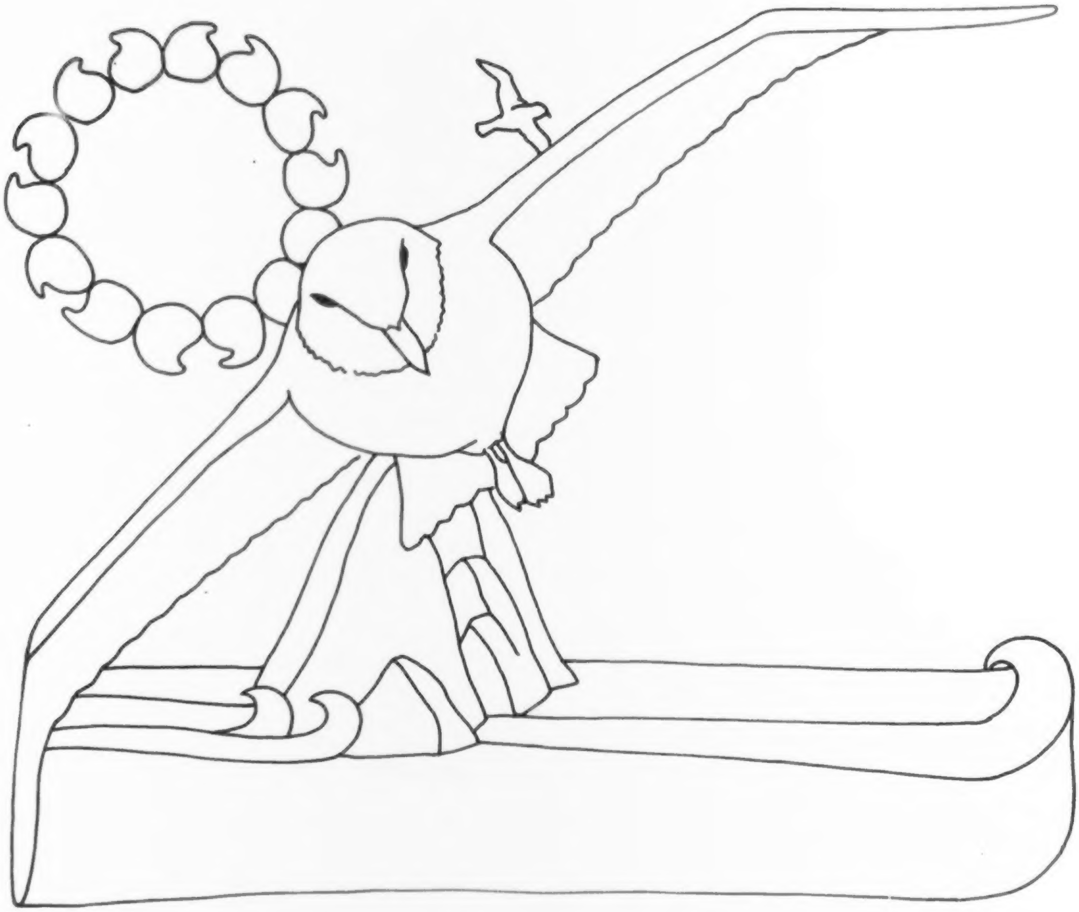
The bright sun shines down on the seaweed forest. The bright sun shines down on the carpet of tiny green and brown plants. The seaweed forest and the thin carpets of plants need sunlight to grow.



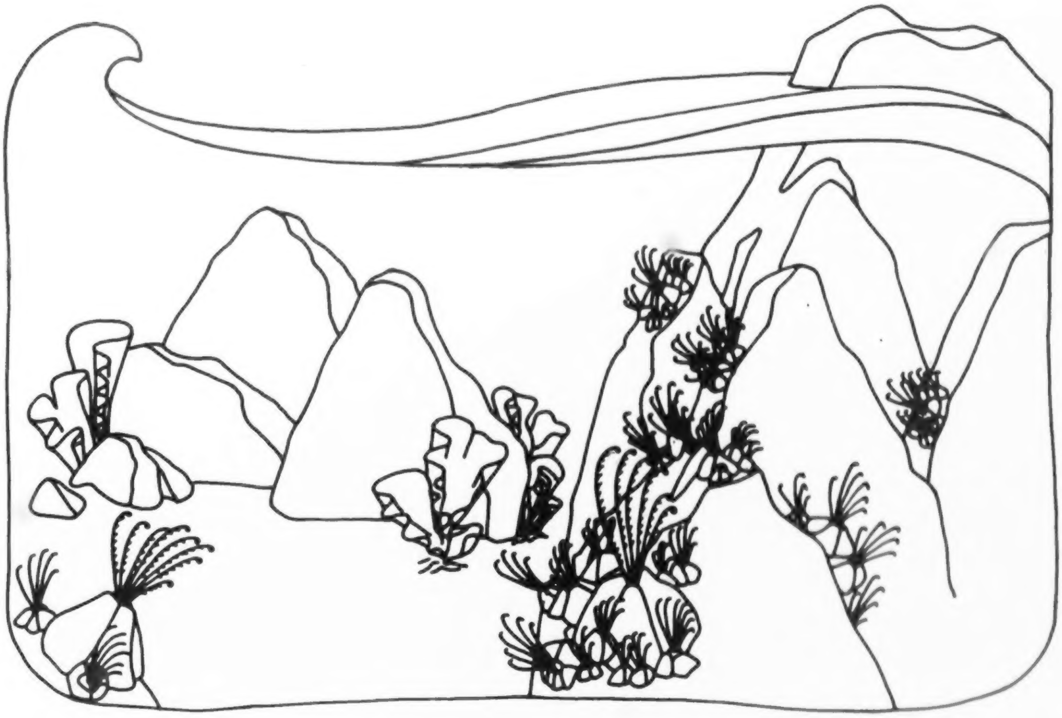


Several large seagulls sit half asleep on the rocks above the seashore. The largest gulls have clean white heads, pale gray backs, and long curved yellowish bills with a bright red spot at the tip. The younger gulls are not so striking in their dull mottled baby brown suits.

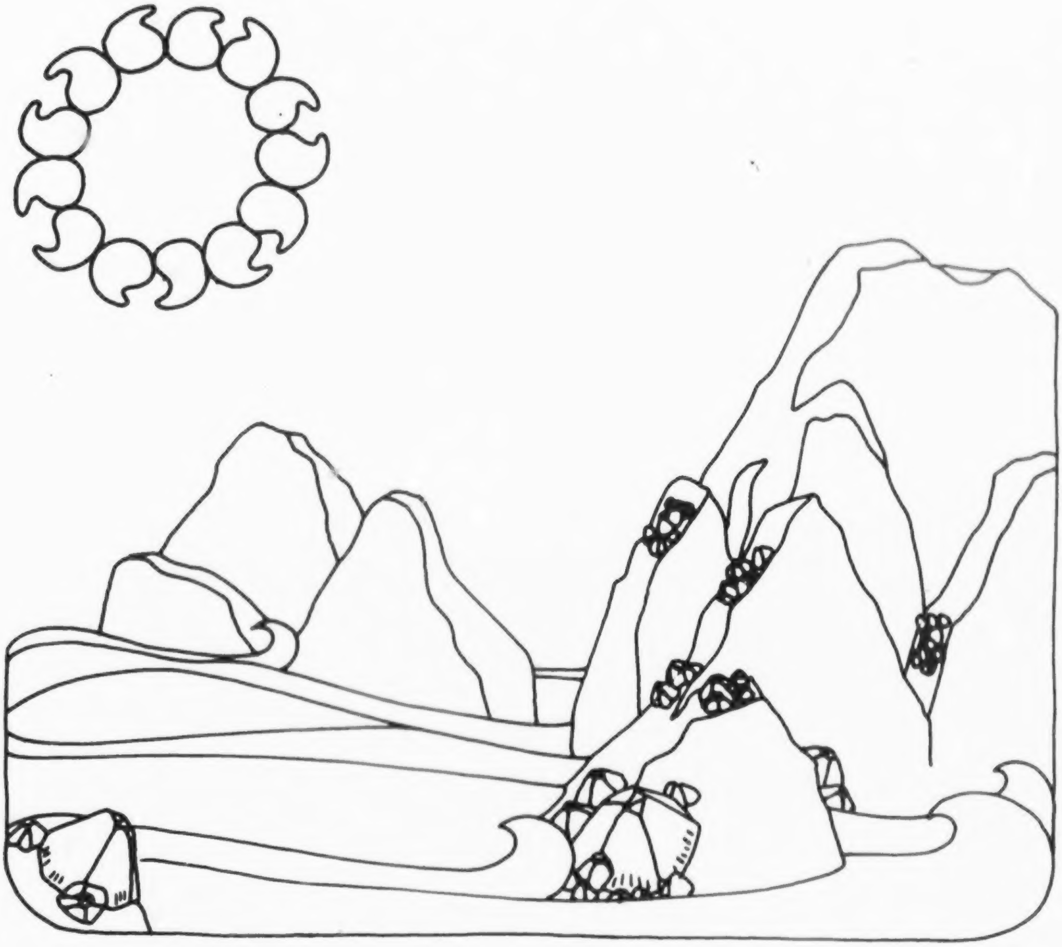
At high tide the seagulls sit half asleep in the warm sunlight. They sit and preen in the sunlight, combing their feathers with their long curved bills. The seagulls sit and listen to the gentle lapping of the waves against the shore.



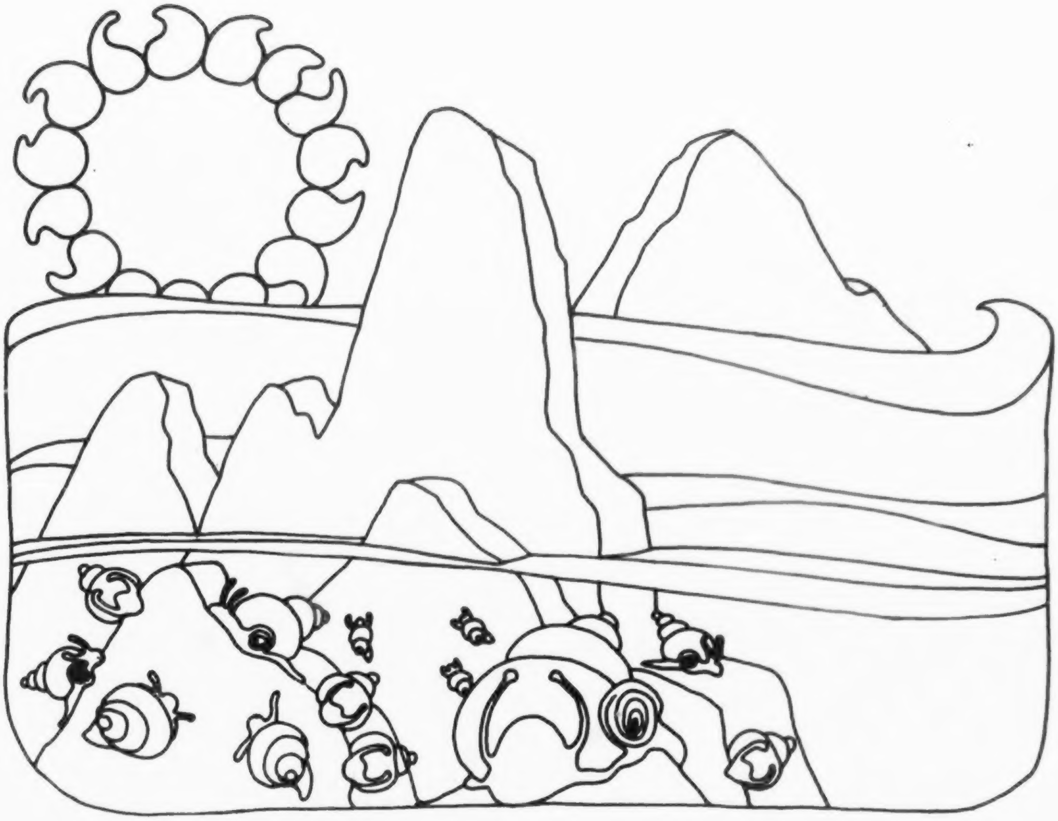
The seagulls that earlier sat half asleep on the rocks above the high water line stir to new life. They pace back and forth, back and forth, along the walls of rock. They probe with their sharp bills in the cracks, crevices, and seaweeds. Always hungry, seagulls eat almost anything -- live fish, dead fish, small crabs, snails, mussels, seastars, worms, even garbage. They squabble and fight other shorebirds to cough up their catch. The seagulls are a part of the garbage disposal crew that keeps the shoreline clean.



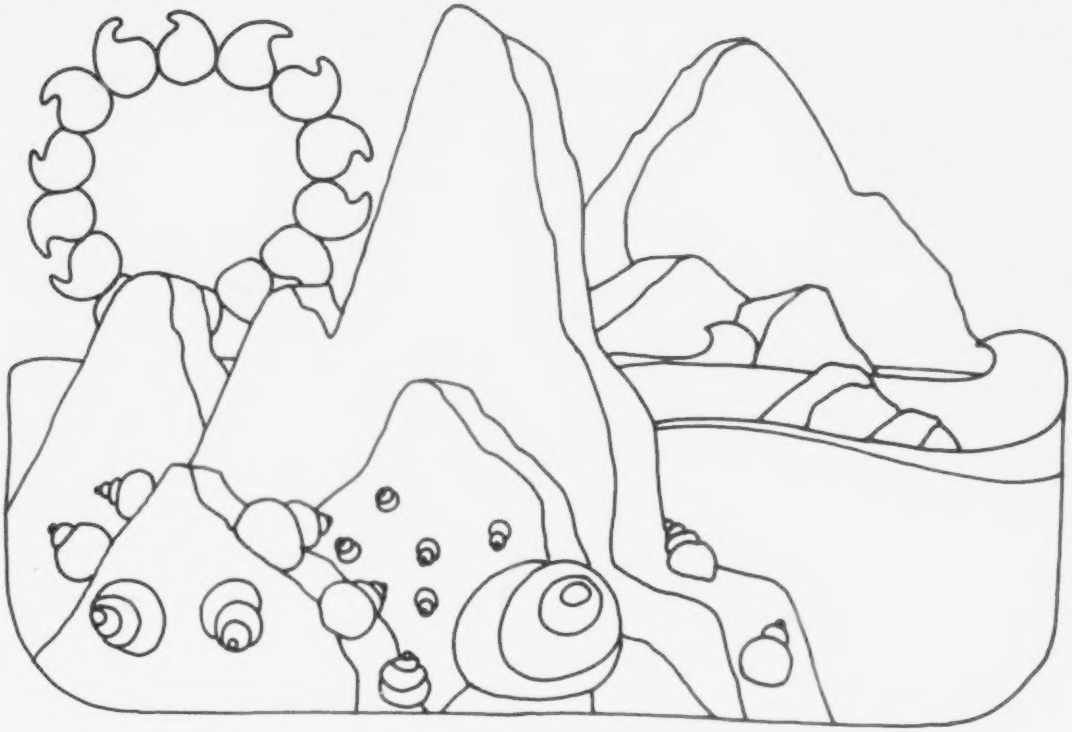
Thousands and thousands of tiny barnacles cover the rocks. Their gray, volcano-shaped shell houses look like thatched fairy castles. The shrimp-like barnacles sit upside down in their shell houses. Each shell house is made of six hard, crusty, plates. When covered with seawater the barnacles open their movable shell plates and throw out their curled, feathery legs. They use their curled feathery legs to make a net, just like a fisherman's net. Every second or so the barnacles use their feathery nets to sweep the plankton soup for tiny plants and tiny animals. At high tide, the barnacles catch tiny plants and animals and kick them down into their mouths.



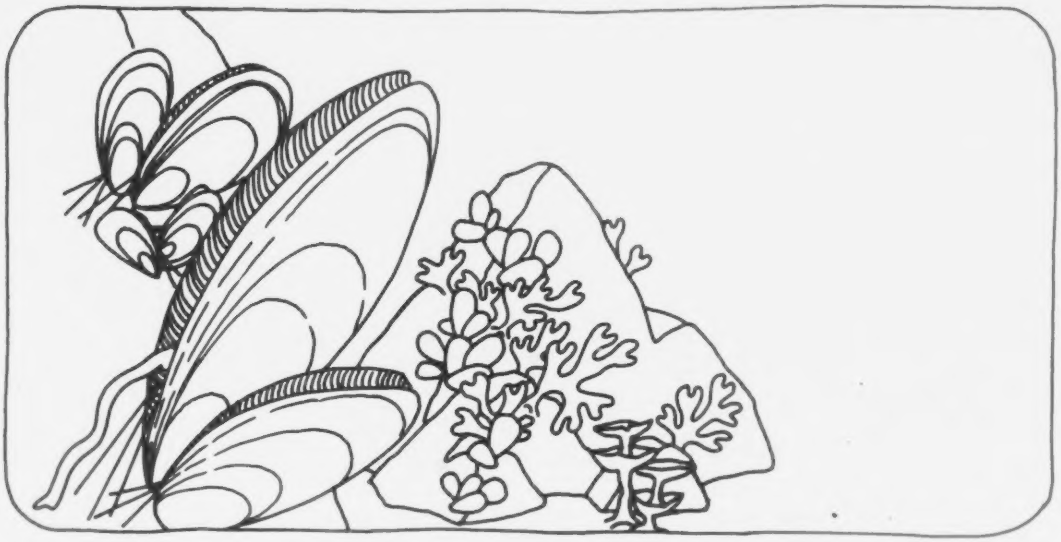
When the water goes out to sea the stoney, volcano-shaped barnacles show no movement or sign of life at all. The six hard, crusty shell plates close up tight in the bright sunlight. The barnacle's shell house makes a moist chamber and keeps the coolness in. The shrimp-like barnacle sits inside its shell house. It sits upside-down in its shell house with its head cemented to the bottom and the long feathery legs curled up tight. The barnacle waits for the rising tide to bring its plankton soup.



Whole herds of dull gray snails, the periwinkles, creep slowly over the rocks. They live among the barnacles and stay as far away from the sea as possible. Periwinkles use their strong, flat muscular foot to move. First one part of the foot moves forward. Then the other part of the foot is pulled along. This is how the periwinkle pushes and pulls and wiggles and waddles along. A periwinkle has a pair of eyes and two long feelers. It also has a mouth and a tongue that feels like sandpaper. At high tide periwinkles scrape the rocks to feed on the thin carpet of tiny green plants that cover the rocks.

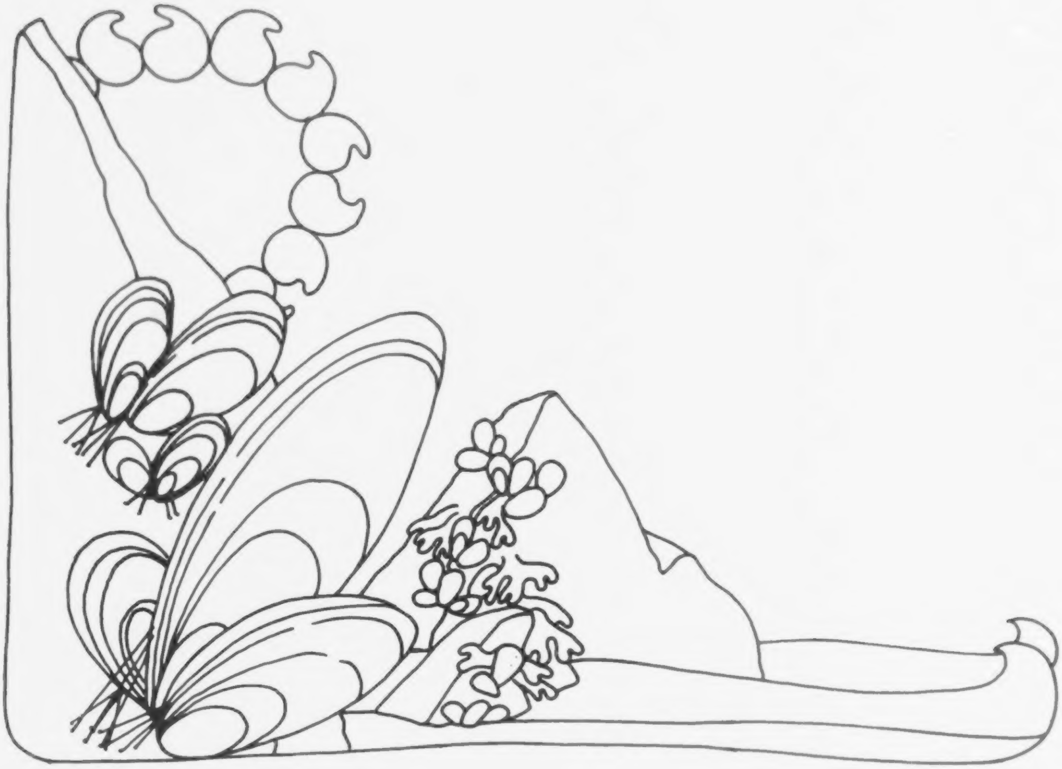


Herds of dingy gray periwinkles crowd the sheltered crevices or sit motionless on sun-lit rocks. Like all snails, each has a little bony plate at the tail-end of the foot. The little bony plate fits perfectly in the opening to the shellhouse, like a trap door. At low tide the periwinkle withdraws into its shell house. It pulls its flat muscular foot, the two long tentacles, and its entire body deep into its coiled shell house. Then the periwinkle seals its house shut by closing the little trap door. The coiled shell house helps protect the periwinkle from the prying claws of a crab or from the long sharp bill of a shorebird. As long as the tide is out, the coiled shell house keeps the periwinkle cool and moist.

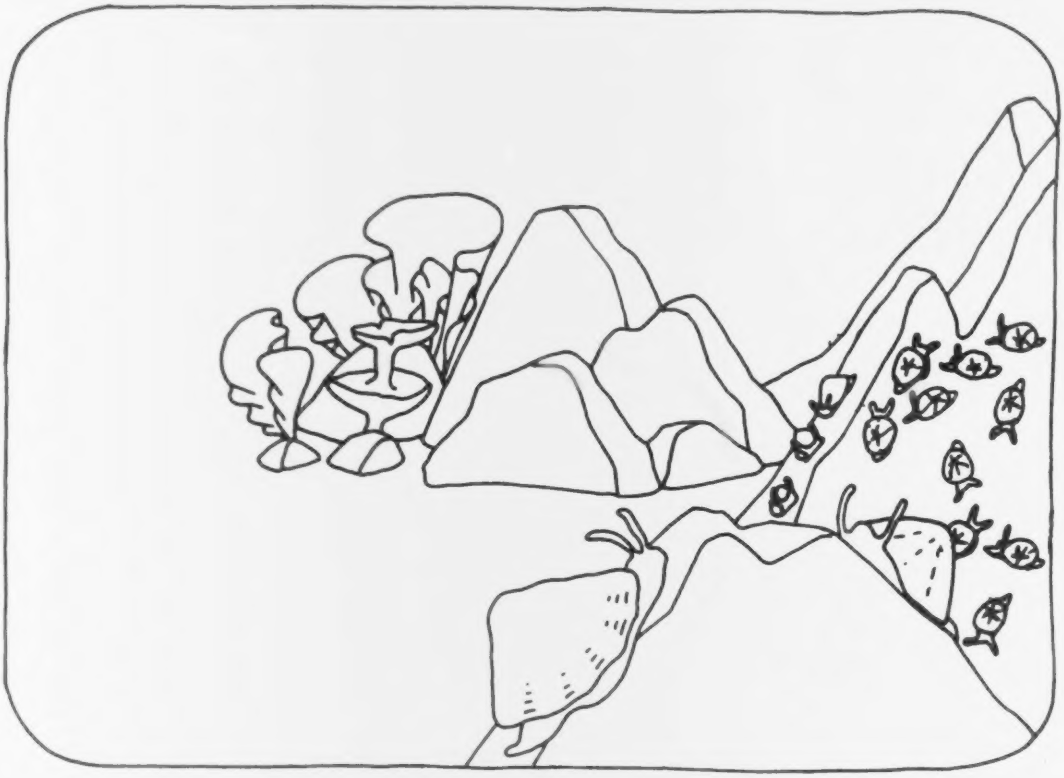


Great beds of towering blue mussels live clumped together on the rocks, in holes, and in crevices. Each mussel has two handsome shells held together by an elastic hinge. It spins its own long elastic anchor threads to attach itself to rocks and to other mussels. When covered with seawater the two shells open slightly, and like the barnacle, the mussel dines on plankton soup.

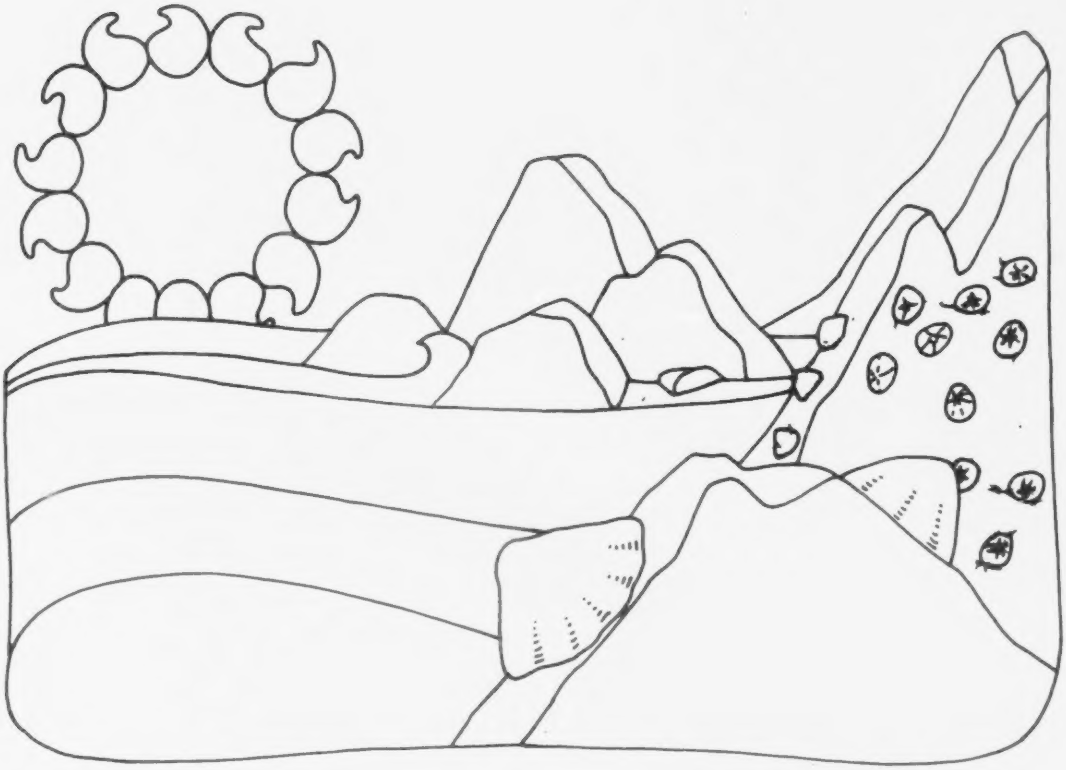
Mussels usually stay in one spot, but should a mussel wish to move, the two shells open slightly and a long slender foot reaches out to break the anchor threads. When the anchor threads are broken, the mussel slowly moves about by using its long narrow foot. When the mussel wishes to stop, the foot reaches out and spins new threads. The long elastic threads, spun into a net of tightly strung ropes, anchor the mussel to its new home.



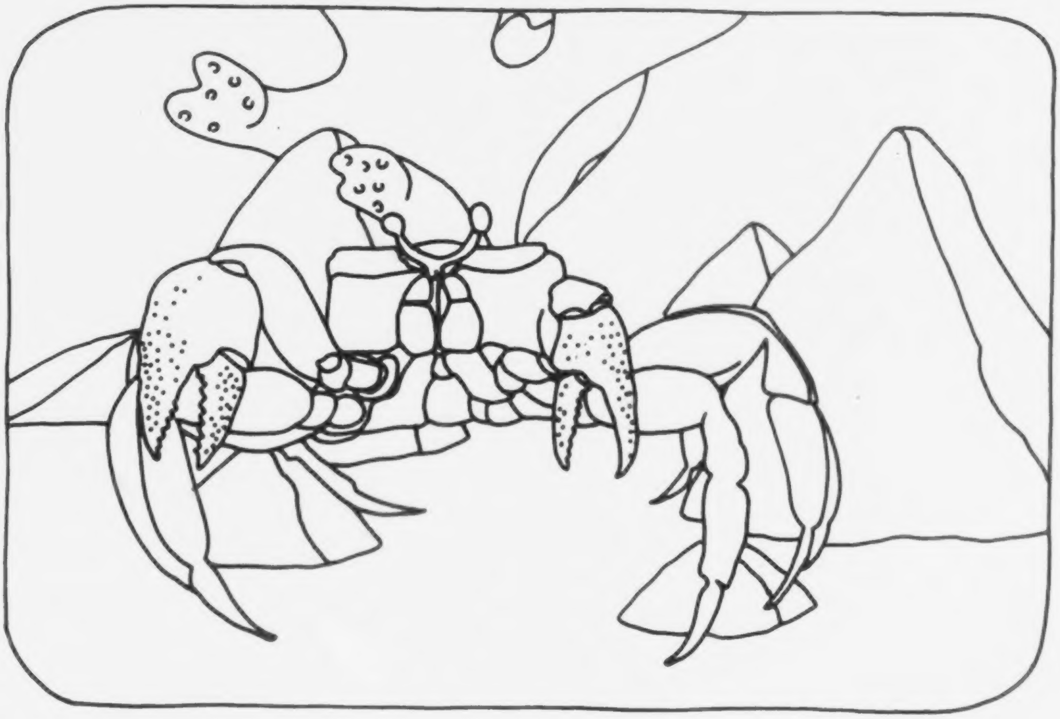
At low tide the blue mussels living in tidal pools are covered with seawater. But where the tide goes out to sea, the blue mussels sit statue-still in the sunlight, as if showing off their twin-shells of blues, blacks, and browns. Whole beds of towering blue shell houses are lashed down by tightly strung anchor threads. Thousands and thousands of rough brown threads are spun into nets of tightly criss-crossing rope. A blue mussel out of seawater closes up tight. It pulls its long thin foot inside and shuts the tightly fitting shells together at the hinge. The sun shines bright, but the blue mussel keeps cool and moist inside its towering twin-shelled house.



Groups of limpets crowd among the barnacles and mussels. Usually brown or gray and speckled with white dots, these cone-shaped animals look like tiny Chinese hats. Like their relatives the snails, limpets have a wide muscular foot which they use for traveling. Each has a pair of eyes, two long feelers and a mouth on the underside of the foot. The tongue is like a long ribbon covered with very fine teeth. When the tide covers the mussel beds, the limpets move busily about; scraping, scraping, scraping the rocks with their tongues of fine sandpaper. The limpets creep among the barnacles and mussels scraping on the thin carpet of tiny green plants that covers the rocks.

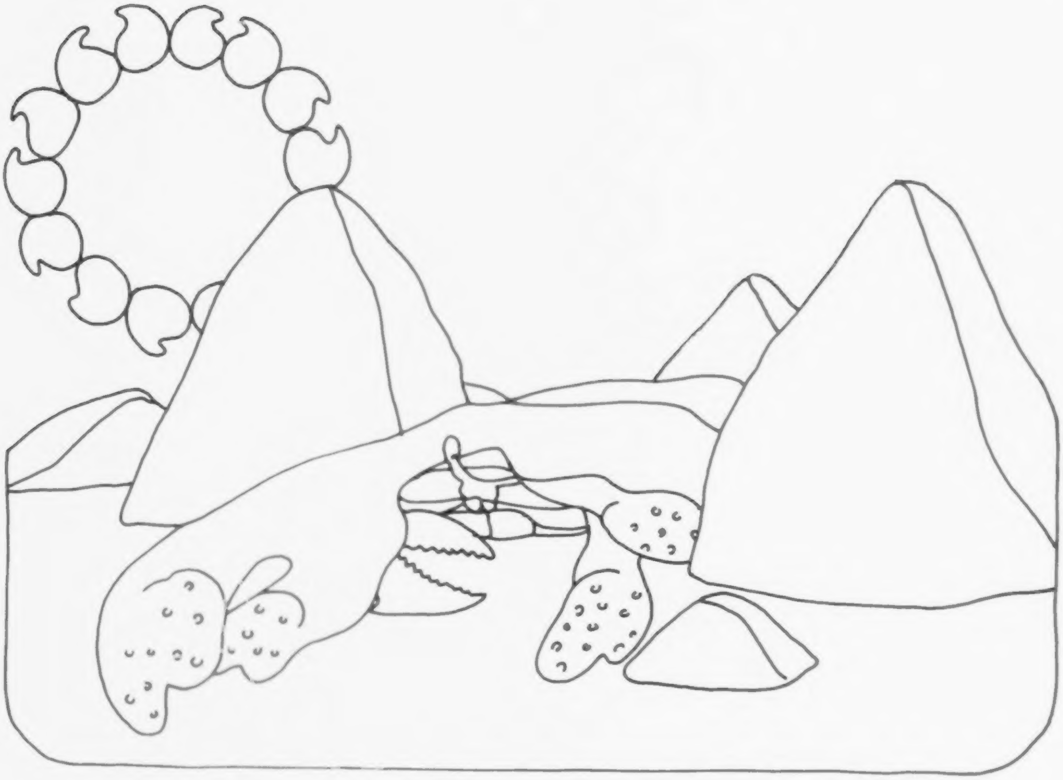


At low tide groups of limpets in tidal pools still graze among the barnacles and mussels. The limpets out of seawater sit stranded on the rocks and in sheltered rock crevices, looking like little armored tanks having run out of gas. A limpet out of seawater stops scraping the rocks for tiny green plants. It pulls its head and the two long feelers inside its cone-shaped shell house. Then, with the wide muscular foot, it plasters itself to the rocks with a very tight suction. The limpet's cone-shaped shell house protects it from hungry crabs, sea stars, and shorebirds and makes a moist chamber for the animal inside its shell.

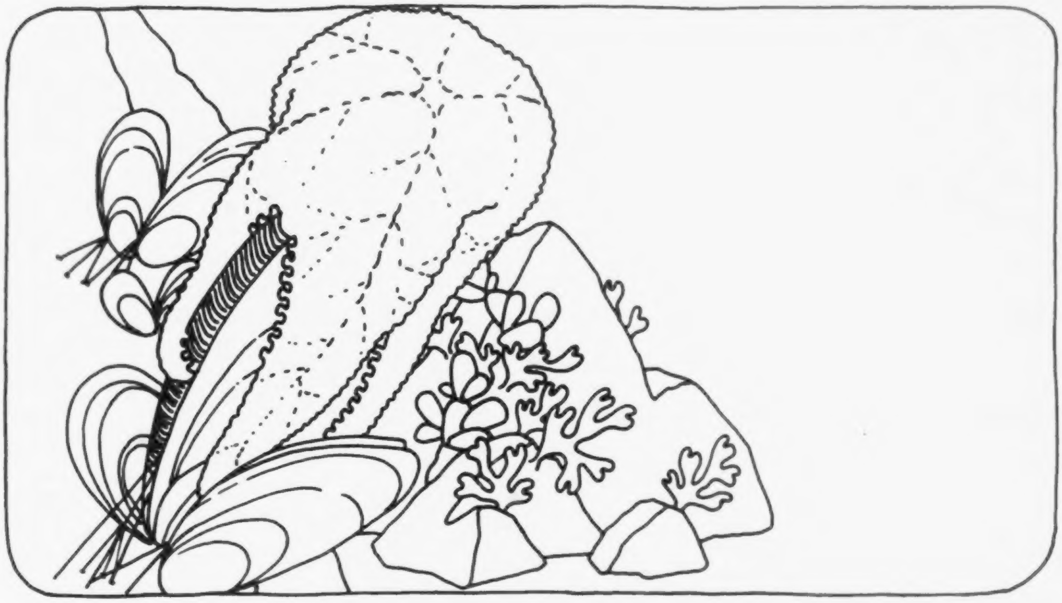


Hundreds of shore crabs scurry across the rocks or creep among gently swaying seaweeds looking for food. They travel equally well forwards, sideways, or backwards. Shore crabs are well protected by their thick armor-like covering. The two heavy claws have great gripping and crunching power. They can easily break open a barnacle's shell house. The claws take the food to the six pairs of movable mouth parts, which tear and crush the food before it enters the mouth.

Shore crabs are not particular about what they eat. In fact, they eat whatever they can find, including dead and dying plants and animals. Like the seagulls, shore crabs act like a garbage disposal crew by removing unwanted waste from the seashore.

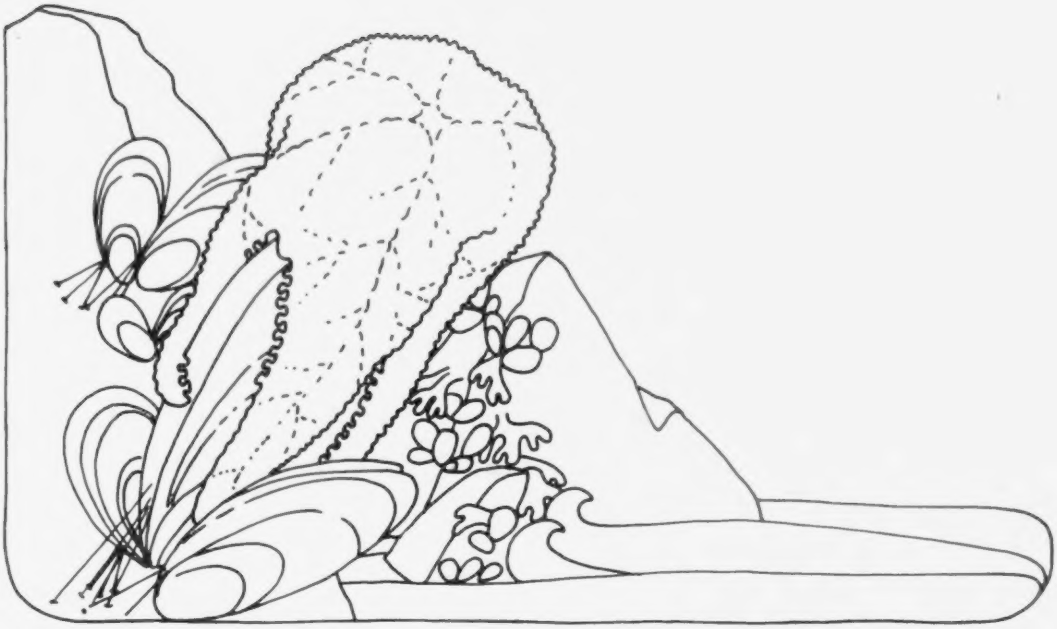


At low tide the hundreds of shore crabs that earlier scurried about looking for food, disappear under rocks, or into rock crevices, or creep into tidal pools. Their thin flat bodies allow them to crawl easily into narrow passageways or dig backwards under large rocks. They fold their two heavy claws in front of themselves to seal the entrance to their under-rock shelters. When the tide is out the rock shelters protect the shore crabs from the drying sun and from the hungry seagulls. As long as shore crabs remain hidden beneath the larger rocks they are fairly safe from the picking and probing of those long sharp bills as the hungry gulls search the shore for food.

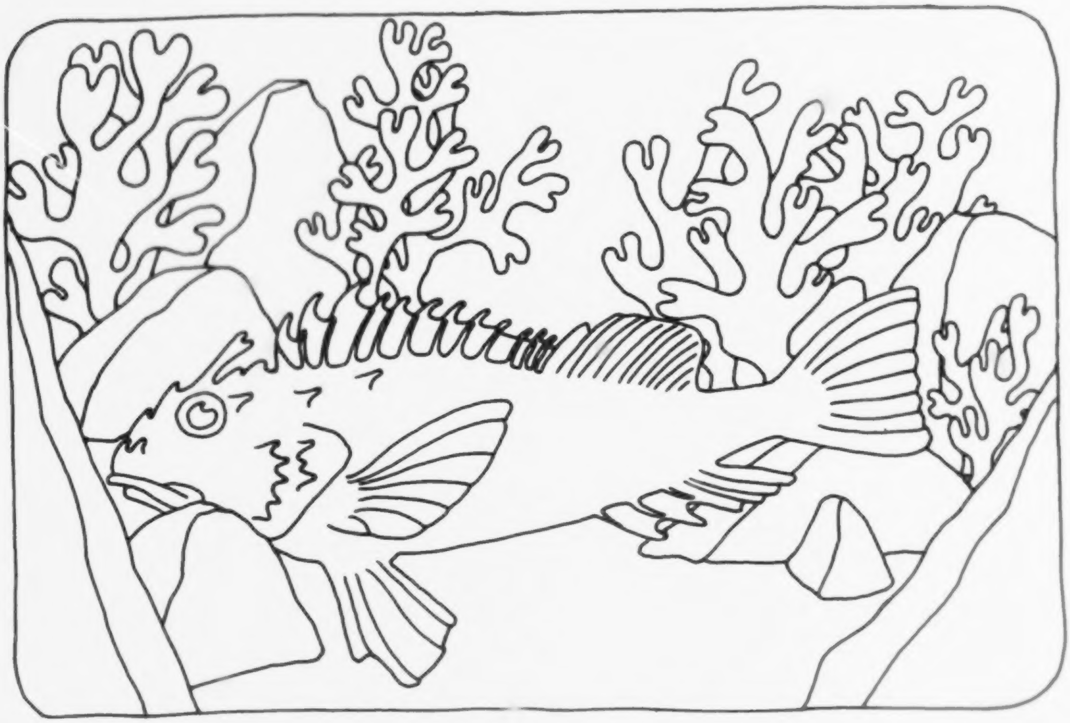


On the rocks just below the mussel beds live the purple or orange sea stars. When covered with seawater sea stars move and hold onto rocks with their many tube feet. At the tip of each tube foot is a water bulb that forms a suction cup, something like a bathroom plunger. When sea stars moves the tube feet work as plungers and levers to pull and shove their bodies forward.

The purple or orange sea star has a big appetite and eats huge numbers of mussels. When attacking a mussel it uses its tube feet to pull and pull and pull, until slowly the mussel tires and the two shells start to open. Then, quick as a wink, the sea star slips its bag-shaped stomach from itself and into the mussel. It may take two or three days, but the hungry sea star digests the mussel right inside its own shell.

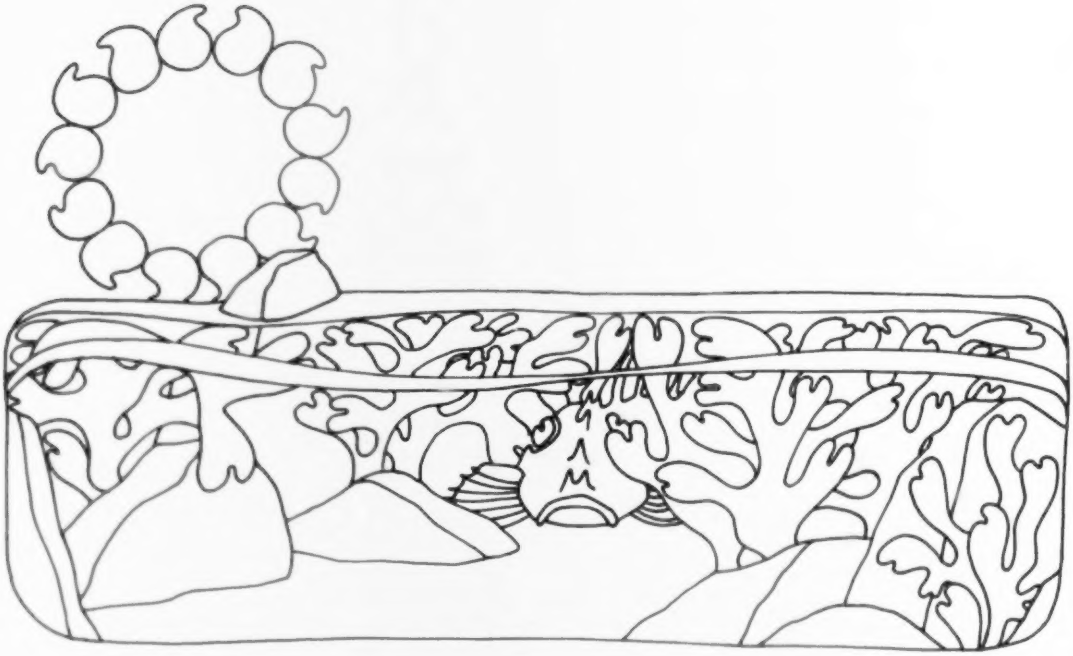


When the tide goes out to sea, that purple or orange sea star below the mussel beds no longer glides gracefully over the rocks or through tidal pools. A sea star out of water stops moving. A sea star needs water to support its large heavy body and water to make its arms and tube feet work. Before the tide goes out a sea star takes in sea water and firmly attaches its tube feet to rocks or to whatever it happens to be eating. As long as the tide is out the sea star remains firmly attached and its hard spiny skin keeps the wetness in. Should a sea star become stranded by the falling tide, its long colorful arms hang down as if dead. A limp sea star is easy to flip over, and is easy food for gulls and other shorebirds.

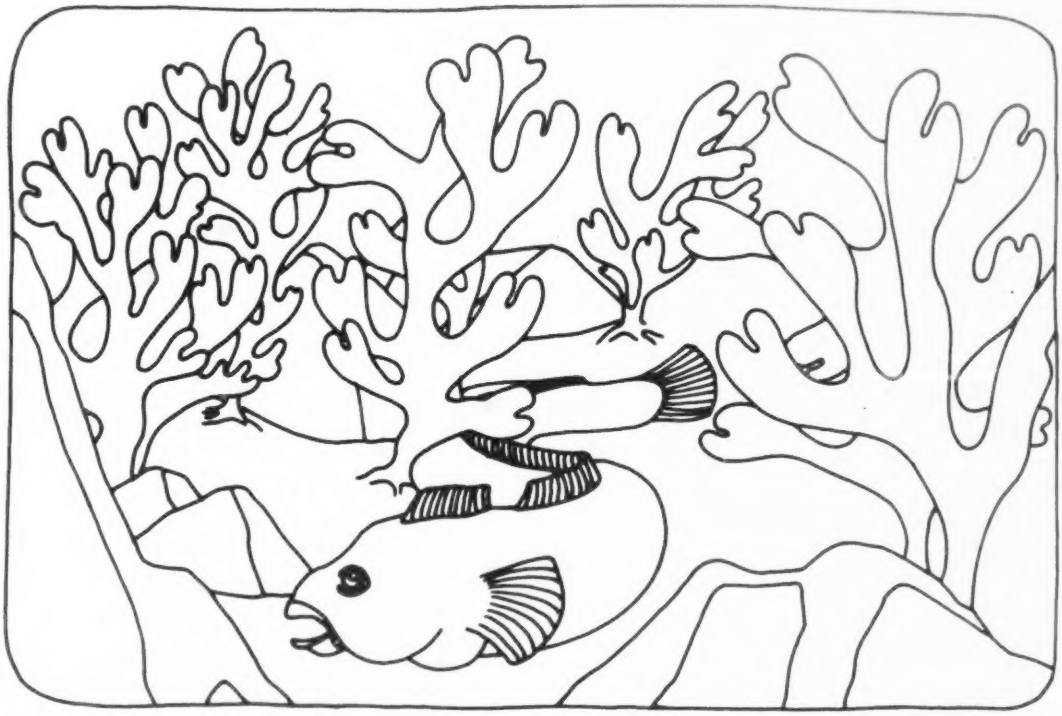


At high tide several strange-looking fish dart here and there on the bottom of the sea. These tidepool sculpins have big heads, large powerful jaws, and long tapering bodies with spiked fins and tails. They walk along on their forward fins or silently glide from rock to rock gobbling up small barnacles, tiny crabs, and snails, and whatever else they can find.

Tidepool sculpins are usually shades of black, brown, or green along with some white. An amazing animal, they can change their colors to match their surroundings. That is why they are called color-change artists. By blending with the rocks, seaweeds, and shadows of the pool a sculpin can go unnoticed, as if it wasn't there at all.

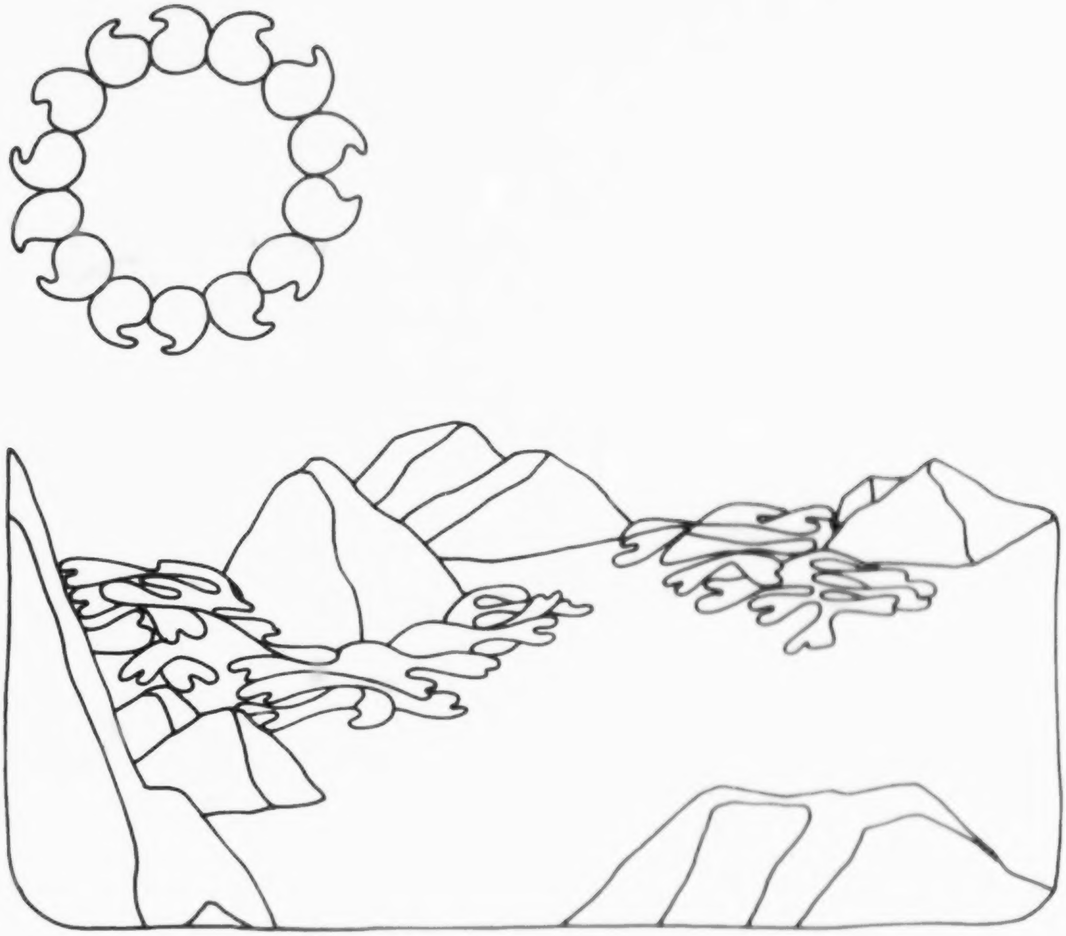


When the tide flows out to sea, tidepool sculpins either swim out to sea with the out-going tide or become stranded in open pools of sea water. They hide under stones or among the seaweeds on the bottom of the pool, where they are fairly safe from gulls and other shorebirds. Tidepool sculpins are such good color-change artists they can often sit on the bottom of the pool, in plain sight. As long as they remain perfectly still they blend beautifully with the rocks, seaweeds, and shadows of the pool. Should a sculpin move, a passing seagull is likely to swoop down, snatch it up, and fly away with the sculpin dangling from its long sharp bill.

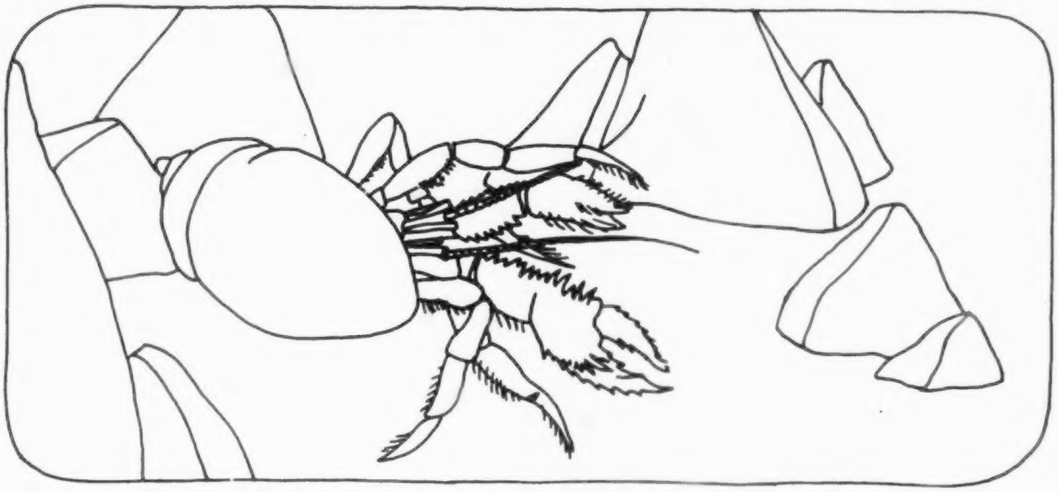


The eel-like blennies are long, writhing fish that swim among the seaweeds and shadows of the sea. The long top fin runs into the tail, making blennies look like eels. Unlike the dreaded eel which produces an electric shock, the blenny is really quite a harmless fish.

Blennies are not so homely as they might first appear. Some are a combination of browns, grays, blacks, and greens. Others are decorated with dots and stripes. Like the tidepool sculpins, blennies are color-change artists. They can change their colors to match their surroundings. At high tide blennies swim snake-like among the shadows and seaweeds, searching for worms, small crabs and snails, and other animals to eat.

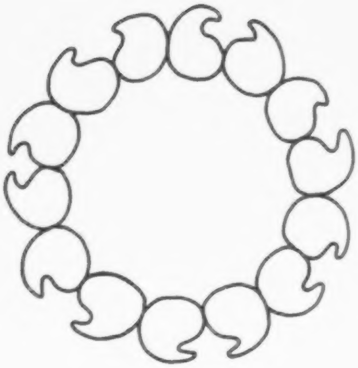


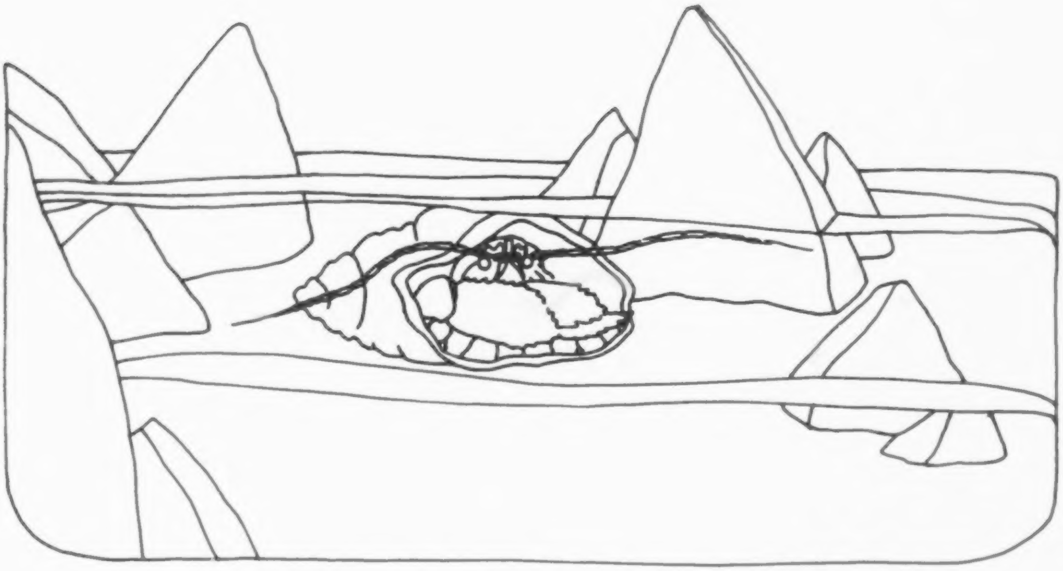
When the tide goes out blennies slither into tidal pools or hide in dark wet places; among seaweeds, under rocks, or in rock crevices. Blennies are covered with a thin coat of slime. As long as they remain in wet places they are as slippery as a wet bar of soap. They wiggle and squiggle and slither and slide into hiding places, rather than risk drying out. These hiding places offer safe shelters from the bright sunlight and from gulls and other hungry shorebirds.



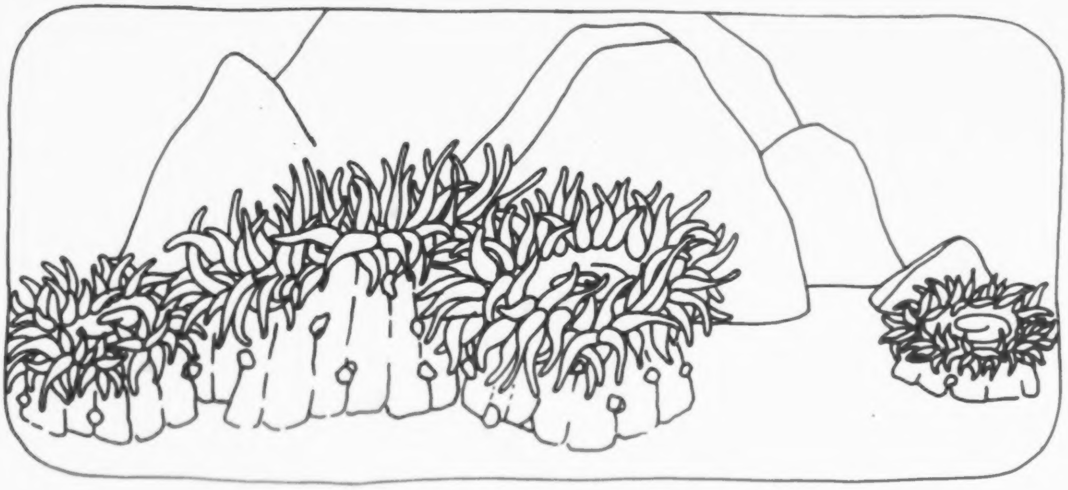
At high tide, the hairy hermit crabs busily go about their daily business looking for food, all the while dragging their portable mobile homes with them. They are funny looking crabs, with eyes on long movable stalks, two very long feelers, six pairs of hairy legs, and a soft curled body. As they grow they must constantly find larger shell houses to protect their bodies.

If two hermits have their eyes on the same empty snail-shell, a fierce battle is sure to follow. The two hermits face each other. Then, with padded boxing gloves held high, the fighters charge, dragging their shell houses along. A hook to the right, a jab to the left, the whirling hermits clench. Their locked claws hold one another down. The two fighters tumble and roll, over and over, until their claws unlock. Then, forgetting the prized snail-shell, the tired hermits retreat, dragging their tattered and worn shell houses along.



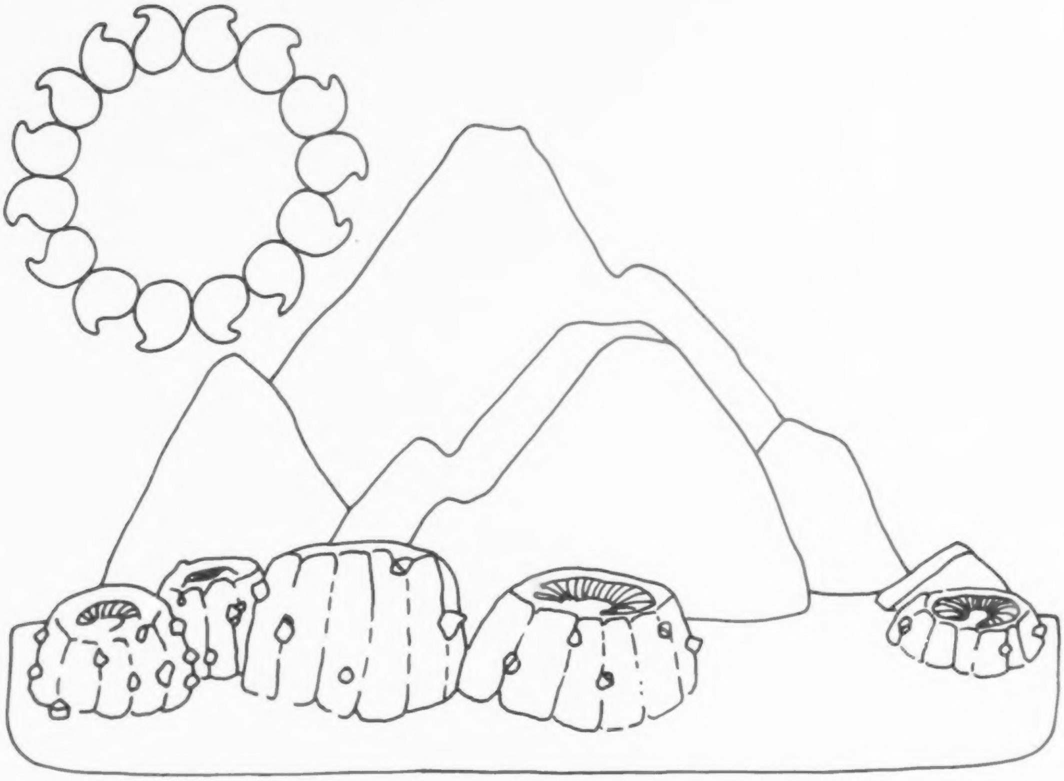


At low tide hairy hermit crabs hop into tidal pools to hide among rocks or seaweeds. The hairy hermit crabs left stranded by the tide stop scavenging for food or fighting battles over empty snail-shells. A hermit out of water pulls its soft curled body, its two long feelers, and its six pairs of walking legs deep into its mobile snail home. It uses its hook-like legs for holding onto the shell house and the large claws for blocking the entrance to the shell.

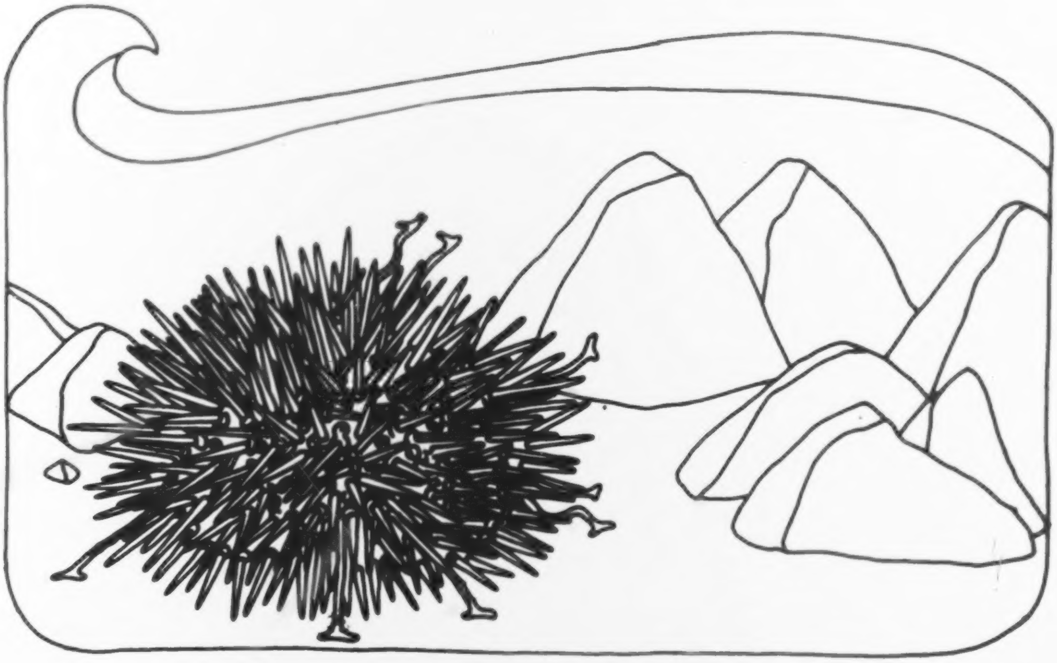


Several large beautiful sea-flowers live on the rocks and in sheltered rock crevices just below the mussel beds. At high tide, or when covered with sea water, these beaded and brightly colored "sea-flowers" wear green, red, pink, gray or white dresses. These flowers of the sea garden are not plants at all, but animals called sea anemones.

Sea anemones are not as harmless as they might appear. Each sea anemone has a sac-like body and ring of stinging tentacles. Inside the ring of tentacles is a round mouth. Should a snail wander too close to a hungry sea anemone, the flowery tentacles quickly fold over it. All the tentacles curl inward and the sac-like sea anemone closes up. No longer a beautiful flower, the sea anemone looks more like a deflated rubber ball. The anemone stings, then digests the snail. After a long, long while the anemone spits out the shiny polished snail shell and opens again to look like a harmless sea-flower.

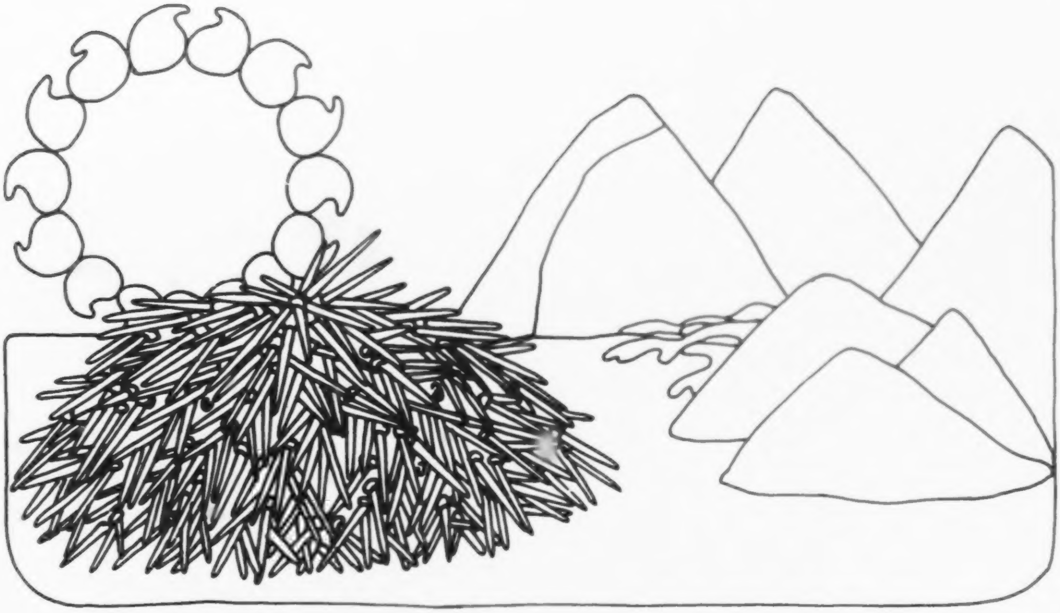


At low tide the sea anemones that are left in deep pools of water still wear their beautiful flower-like dresses. But those that are left stranded on the rocks by the dropping tide shrink to half their size. Before the dropping tide uncovers them, sea anemones draw in their tentacles and close up their sac-like bodies, with their stomachs full of water. They close the tops of their bodies like purse strings pulled tight. No longer beautiful sea flowers, they look more like jelly blobs on the sides of rocks. These soft and naked sea anemones survive in the hot sunlight, at least long enough for the tide to return and cover them.



Huge herds of sea urchins, some red, some purple, some green, graze among the sea anemones. These "sea-porcupines" have long thin tube feet and a forest of long bristling spines. The tube feet cling to rocks with little suction cups and help to pull the sea urchin along, while the long sharp spines all push in the same direction. Should a hungry sea star or rock fish pass by, the long sharp spines all point, like spears, in the direction of the would-be enemy.

Sea urchins feed mostly on seaweeds. The five teeth on the underside of the sea urchin come together to make a powerful scraper. Huge herds of sea urchins graze among the seaweed forest; scraping, scraping, scraping at the seaweed forests, until whole forests are cut away at the roots.



When the tide drops very, very low on the shore, the bristling sea urchins come into view. As the tide goes out, some sea urchins go on grazing in deep tidepools. Some retreat with the dropping tide. Others become stranded in crevices or on dry rocks lit by the bright sunlight.

A sea urchin out of water is like a porcupine with limp quills. Without the surrounding water to give the sea urchin support, the forest of long sharp spines hangs down, the long thin tube feet that are not attached to rocks withdraw, and the sea urchin stops moving. Before the tide drops, a sea urchin attaches some of its sucking tube feet to rocks and digs it long sharp spines into cracks and crevices. As long as the tide is out, the sea urchin keeps a strong foot-hold and stays cool and wet inside its bristly water-filled shell house.

When you visit the rocky shore it will be much more interesting if you can make discoveries yourself. You can find more plants and animals when the tide is low. Look carefully in tidal pools, among seaweeds, and under rocks. When you explore a tidal pool, watch the animals on the spot. Don't collect them. If you pick up an animal, put it back where you found it. If you turn over rocks, carefully put them back in the same place. By doing this, you will not disturb the animals and their living places. Then more people will have a chance to enjoy the rocky shore and see how rocky shore plants and animals live in their own homes.